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ABSTRACT

This document is designed to help vocational/tech prep and applied academics teachers plan and present their subject matter in a more integrated manner. The introduction presents the rationale for the ideabook. It is designed to help teachers modify their instructional program to more closely match the demands and realities of the real world. The document's four sections are: "About Vocational-Academic Integration" (the integration continuum and the infusion, linked, and multidisciplinary strategies); "Integration Ideas: Activities and Strategies" (teach thinking strategies; use authentic assessment tools such as portfolios and performance assessments; use rubrics; use periodicals; simulate the workplace; incorporate projects; use demonstrations and discovery; use planning tools that support integration; and devise joint plans with other teachers); "The Information Superhighway" (the Internet, e-mail, Usenet newsgroups; mailing lists; Internet access; mega-websites; and recommended websites); and "Curricular Resources for Applied Academics" (resource catalogs; resources for applied communications, applied mathematics and science, applied mathematics, and applied science; and contact information). Concluding the document are sample pages from the Ohio Department of Education's Occupational Competency Analysis Profile. Three annotated bibliographies included in the document contain a total of 46 print resources and 18 website addresses. (MN)

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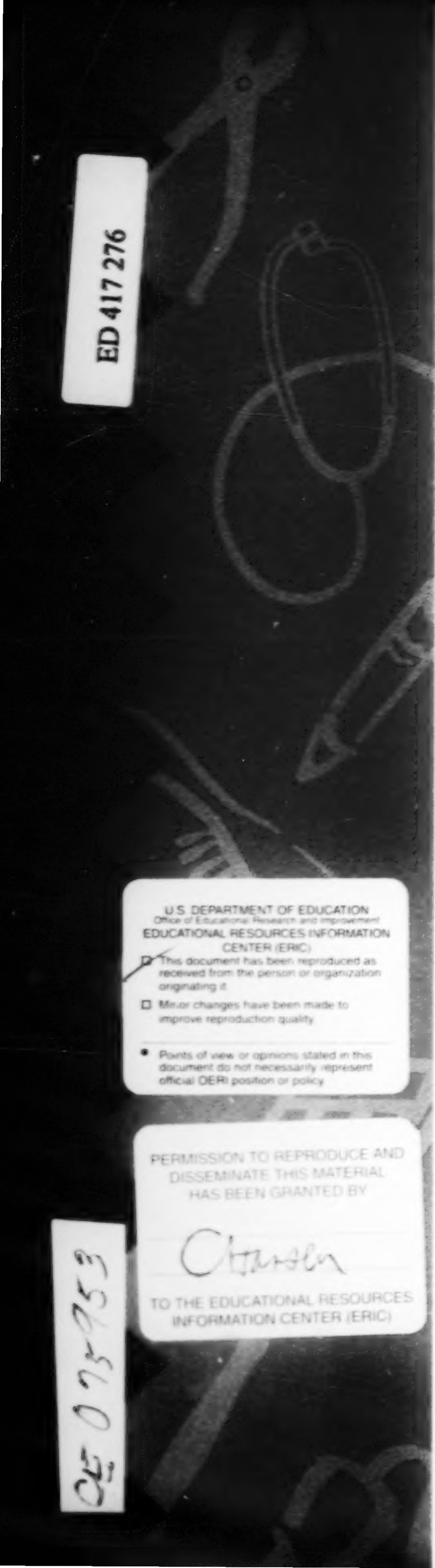

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Making Connections:

A Curriculum Ideabook for Teachers of Applied Academics and Industrial & Engineering Systems

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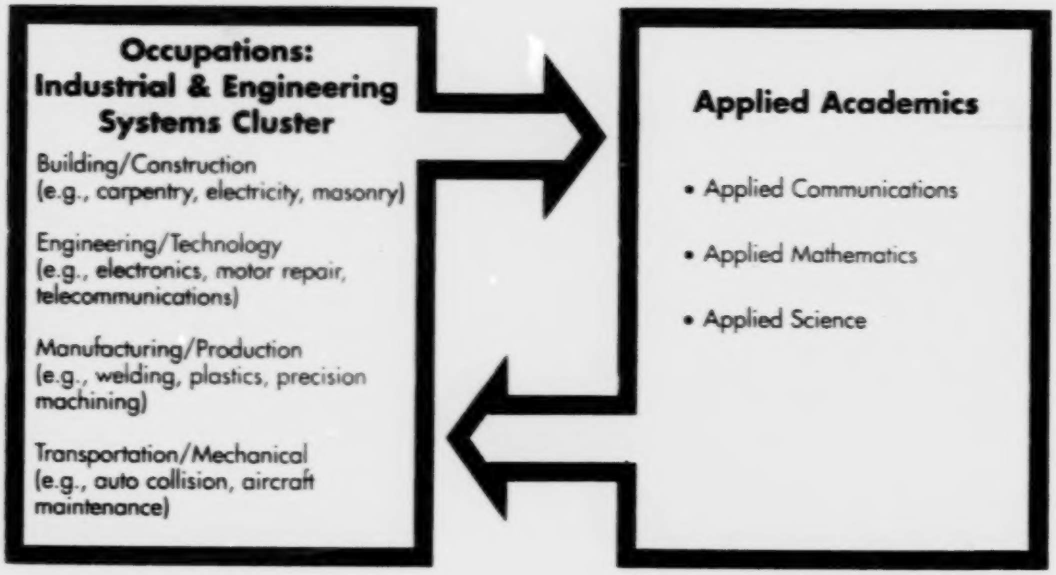
Making Connections:
A Curriculum Ideabook
for Teachers of
Applied Academics and
Industrial & Engineering Systems

The Ohio State University
Vocational Instructional Materials Laboratory
1900 Kenny Road
Columbus, Ohio 43210-1016

1998

"When you reach for the stars, you may not quite get one,
but you won't come up with a handful of mud either."

Leo Burnett, quoted in Communications Briefings, August 1995



Occupations: Industrial & Engineering Systems Cluster

Building/Construction
(e.g., carpentry, electricity, masonry)

Engineering/Technology
(e.g., electronics, motor repair, telecommunications)

Manufacturing/Production
(e.g., welding, plastics, precision machining)

Transportation/Mechanical
(e.g., auto collision, aircraft maintenance)

Applied Academics

- Applied Communications
- Applied Mathematics
- Applied Science

Work SITE Learning Model

Ohio's Work SITE Learning Plan

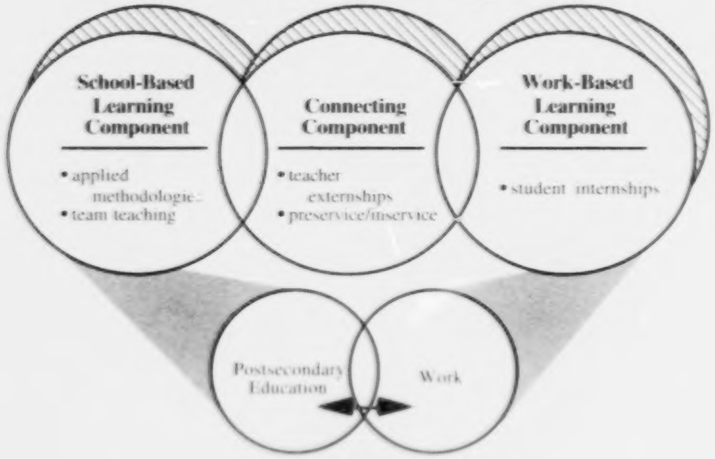

School-Based Learning Component
• applied methodologies
• team teaching
Connecting Component
• teacher externships
• preservice/inservice
Work-Based Learning Component
• student internships
Postsecondary Education
Work

Figure 1

Project Overview

Ohio's Work SITE Learning Model is the product of a national demonstration project for the integration of academic and vocational learning, funded by the U.S. Department of Education. The model comprises three components. Help in replicating each of these components is provided through three implementation guides developed as part of this project:

- **Connecting Component:** To help ensure that teachers are prepared to serve as a link between the workplace and the school setting, teams of academic and vocational teachers should participate in short-term worksite externships focusing on the use of academics on the job. Those wishing to create teacher externship experiences can get assistance from *Helping Teachers Connect Academics to the Workplace: An Implementation Guide for Teacher Worksite Externships.*

- **School-Based Learning Component:** Following the externship experiences, teams have a more-solid basis for developing activities for the classroom and laboratory that require the use of academics within an authentic workplace context. Vocational teachers can also collaborate with

These three guides are available from the Vocational Instructional Materials Laboratory (VIML) at The Ohio State University. The sales office is located at
1900 Kenny Road,
Columbus, Ohio 43210;
(614) 292-4277;
(800) 848-4815, ext. 2-4277;
fax (614) 292-1260.

academic teachers in incorporating into applied academic classrooms the concrete, hands-on methodologies that have proved so successful with the vocational student population. Help in developing applied academic activities can be found in *Making Connections: A Curriculum Ideabook for Teachers of Applied Academics and Industrial & Engineering Systems.*

- **Work-Based Learning Component:** To reinforce for students the fact that academic skills are critical to success in the workplace—and are highly valued by employers—students, too, need to spend time in the workplace, focusing on the use of academics on the job. Early in the first year of a vocational program, teachers should arrange for student worksite learning experiences (SWLEs) through which students observe how academics are used in local business and industry, health care, government, or social service agencies. *Helping Students Connect Academics to the Workplace: An Implementation Guide for Student Worksite Learning Experiences* is designed to help schools develop SWLE programs.

The following improvements may result from these efforts to connect school and work:

- Teaching team members often become more united, enhancing their abilities to jointly assess how academics are applied to a given occupation.

- Teaching team members are more likely to collaborate in planning, preparing, and delivering academics that are integrated with occupationally specific education.

- Teaching team members are better prepared to structure meaningful student worksite learning experiences for their students.

- Students who have participated in SWLEs are more likely to understand the connection between academic and vocational studies—because they have seen it in practice in the workplace.

ACKNOWLEDGMENTS

This Ideabook is the product of many people who committed their time and talents to helping make it a useful resource for educators wishing to integrate academic and vocational/tech prep curricula.

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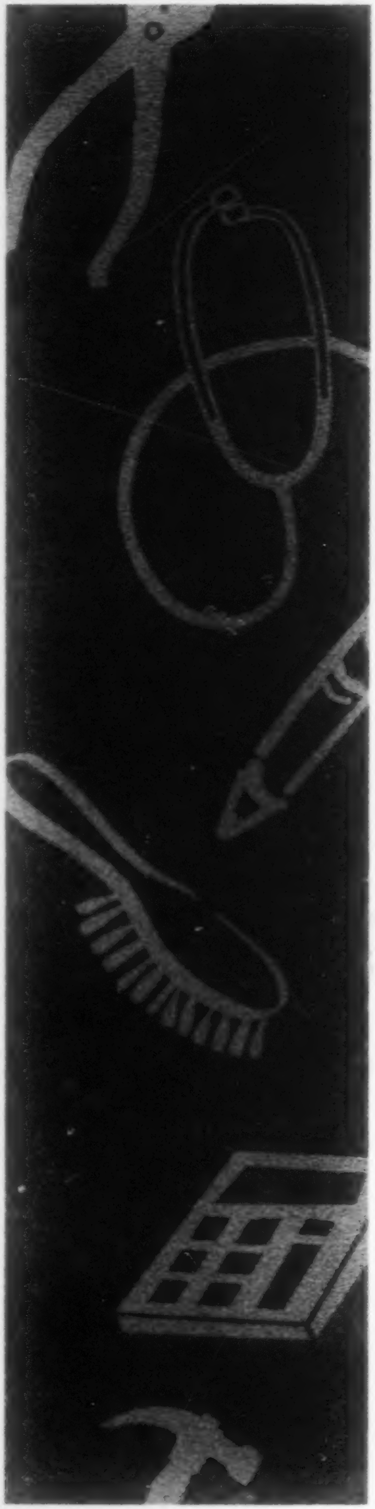

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The Ideabook: An Introduction

The Ideabook: An Introduction

This Ideabook was developed to help both vocational/tech prep and applied academics teachers plan and present their subject matter in a more integrated way. Let's start with a look at why such a book is needed.

A Curriculum Divided

The American educational system has long divided learning into its separate parts in order to simplify the teaching process. Thus, students learn English from English teachers, mathematics from mathematics teachers, science from science teachers, and vocational subjects from vocational teachers. There are in fact students who thrive in this environment, who relish the learning of abstract concepts taught in isolation. But there are many, both in vocational/tech prep and college prep programs, who do not.

***Scenario:* Marvetta is an underachiever. She can be relied upon to do her English homework assignments on time, but the work is clearly done at the last minute, with a minimum amount of effort expended. Yet Marvetta spends long hours working on the school newspaper. Why can't she bring that devotion and concentration to bear on her English assignments?**

Marvetta is not alone. For some students, classwork is busywork—something done for the teacher, with no relevance to the real world. They don't take it seriously. Yet when the work is real—publication of a school newspaper—their motivation and effort increase dramatically.

For some students, classwork is busywork with no relevance to the real world.

It's not just a motivational issue. Some students—again, both vocational/tech prep and college prep—do not understand concepts taught purely on a theoretical level. Until they see the concept in its application, they do not grasp it. They may memorize it for a test, but it slips and slides out of their mental database as soon as the test is over. The student studying auto mechanics may react this way to information about subjective and objective cases of pronouns in English class. The student hoping to major in English in college may react this way to information about sine, cosine, and tangent in advanced mathematics class.

Some students do not understand concepts taught purely on a theoretical level.

If you have ever taken a foreign language, you have probably said at some point, "Well yes, I took French (or Spanish or German or whatever) for x number of years, but I don't remember much. I never had to use it, you know." We acknowledge this, yet we don't apply this knowledge in our own classes. After all, we're teaching a subject we love, and surely the students will share that love if only we can convey it with the proper skill and enthusiasm.

Scenario: The English teacher is covering a simple grammatical concept. Once the concept has been taught, he tests the students. The majority fail the test. So the English teacher regroups and teaches the concept using a different approach. When he next tests the students, many more pass the test. But this is a new English teacher, and he is determined that ***all*** *students should pass. So he keeps trying. Finally all students pass a test on the concept. The English teacher is thrilled ... until he discovers that few of the students apply the concept correctly in their writing or speaking. They only apply it on tests covering the concept in isolation.*

This is another flaw in a system in which knowledge is broken down into separate parts. If students treat grammar lessons as separate—and unrelated to speaking and writing—in English classes, imagine what happens to that knowledge when they walk across the hall to mathematics or science or history class. Clearly, in their minds, grammar is not relevant to those classes.

Integrating the Curriculum

How do you solve the problem of the fragmented curriculum? Since there is no sign that classes will cease to be divided in this way in most schools in the near future—or ever—what can be done?

If you are an applied academics teacher—

- First, ensure that concepts are taught in an applied, hands-on fashion.
- Second, ensure that classroom activities reflect the real world. Require students to draw on what they have learned in many different classes in order to solve complex problems.

If you are a vocational teacher—

- Foster respect for—and systematically reinforce—the academic skills students will need to succeed in the world of work.

Why Should You Use This Approach?

When the emphasis in the classroom is on hands-on application and solving of real-world problems, the instructional methodology switches from one that is teacher-centered (lectures, demonstrations) to one in which students are highly active and involved—a prerequisite to learning. When you have the sole responsibility for action in the classroom, ***your*** teaching may or may not result in ***student*** learning. But when students share actively in the action, they are bound to discover and grow and learn.

When students share actively in the action, they are bound to discover and grow and learn.

An approach that increases student learning and retention is ***critical*** given today's world of work. (And most students—not just those in vocational education—will end up in that world sooner or later.)

What does the work world demand these days?

- The world of work demands teamwork—yet we primarily require individual effort in the classroom.
- It demands problem-solving and thinking skills—yet we primarily focus on mastery of individual concepts as measured on objective tests (true-false, completion, multiple-choice, matching).
- It demands lifelong learning skills, since information and technology now change so rapidly—yet we plan our courses as if we had to teach students everything they need to know for a lifetime.

The competencies and foundation skills and qualities required for the work world were identified and defined by the Secretary's Commission on Achieving Necessary Skills (SCANS) in 1991. These are presented at the end of this section, pp. 8–14.

How This Ideabook Can Help You

This Ideabook is designed to help you modify your instructional program to more closely match the demands and realities of the real world. It was developed as part of a project on academic-vocational integration that began with an extensive survey of what teachers in Ohio are doing to integrate academic and vocational instruction. It began, in short, with a detailed picture of ***reality***:

- We know, for example, that you may be a new teacher with a major in mathematics who thought you'd be teaching college prep mathematics and found yourself instead teaching something called ***applied mathematics*** to auto mechanics students—this despite the fact that you may not even know where to add the oil in your own car. Worse, you're in a totally separate building from the auto mechanics teachers and rarely, if ever, have the opportunity to talk with them, let alone plan jointly. Furthermore, the other mathematics teachers in your department make it very clear that they feel your applied mathematics courses are not "real math."
- Or, you may be an ***applied science*** teacher who worked very hard for two years with your vocational counterpart to develop activities relevant to your students, who were all in health occupations programs. You have just gotten your assignment for next year and have discovered that the students in your applied classes will all be students in electricity and electronics programs.
- Or, you may be an ***applied communications*** teacher who is being told by the vocational department that you must focus strictly on the communications competencies needed for the occupational area. Yet your English department chair says that you must focus strictly on the English competencies identified by the State as essential for that grade level. So, do you teach Shakespeare or the skills needed to read job specs?

- Or, you may be a ***vocational*** or ***tech prep*** teacher who has always done a good job teaching occupational skills and the academic and employability skills related to them. You've always been happy working within your department and don't see any reason to get involved with those academics who, in your opinion, don't understand the occupation or the real world of work at all.

The situations around the state vary greatly. For every worst-case scenario, there is its opposite. There are supportive administrators, vocational and academic teachers working in tandem, and schedules and facilities supporting integration. The point is this: Regardless of your situation, there is a step you can take to move further along the road to integration.

Regardless of your situation, there is a step you can take to move further along the road to integration.

The ideal is ***fully integrated instruction***—for one very good reason: it provides students with a better education and prepares them more effectively to enter and succeed in the world of work:

- When teachers work as teams, they are modeling teamwork.
- When teaching teams—made up of teachers with different specialties—pool their strengths to reach their goals, that reflects the reality of the world of work.
- When students are required to apply all the skills they learn—in an orchestrated manner—in order to solve real problems, they are learning how to function in the workplace of today and tomorrow.

However, if the ideal and your own situation seem worlds apart, you need not throw your hands up in despair. The old cliché holds true: Rome was not built in a day. You can improve your situation, one step at a time:

- Look at the ideas in this book.
- Immediately try those that are within your power.
- For the rest, think about what you'd like your "classroom" to look like, in terms of integration, in five years.
- Determine the steps you will take and the support you will need to get there.
- Then get started—step by step.

What Work Requires of Schools: A SCANS Report for America 2000 (Washington, DC: Secretary's Commission on Achieving Necessary Skills, U.S. Department of Labor, June 1991), pp. B-1, B-2, C-2, C-3.

SCANS Competencies

Resources

Allocates Time

- Selects relevant, goal-related activities.
- Ranks activities in order of importance.
- Allocates time to activities.
- Understands, prepares, and follows schedules.

Allocates Money

- Uses or prepares budgets, including making cost and revenue forecasts.
- Keeps detailed records to track budget performance.
- Makes appropriate adjustments.

Allocates Material and Facility Resources

- Acquires, stores, and distributes materials, supplies, parts, equipment, space, or final products in order to make the best use of them.

Allocates Human Resources

- Assesses knowledge and skills and distributes work accordingly.
- Evaluates performance, and provides feedback.

Interpersonal

Participates as a Member of a Team

- Works cooperatively with others and contributes to the group with ideas, suggestions, and effort.

Teaches Others

- Helps others learn.

Serves Clients/Customers

- Works and communicates with clients and customers to satisfy their expectations.

Exercises Leadership

- Communicates thoughts, feelings, and ideas to justify a position.
- Encourages, persuades, convinces, or otherwise motivates an individual or groups, including **responsibly** challenging existing procedures, policies, or authority.

Negotiates

- Works toward an agreement that may involve exchanging specific resources or resolving divergent interests.

Works with Cultural Diversity

- Works well with men and women and with a variety of ethnic, social, or educational backgrounds.

Information

Acquires and Evaluates Information

- Identifies the need for data.
- Obtains data from existing sources or creates needed data.
- Evaluates the relevance and accuracy of the data.

Organizes and Maintains Information

- Organizes, processes, and maintains written or computerized records and other forms of information in a systematic fashion.

Interprets and Communicates Information

- Selects and analyzes information.
- Communicates the results to others using oral, written, graphic, pictorial, or multimedia methods.

Uses Computers to Process Information

- Employs computers to acquire, organize, analyze, and communicate information.

Systems

Understands Systems

- Knows how social, organizational, and technological systems work and operates effectively within them.

Monitors and Corrects Performance

- Distinguishes trends.
- Predicts impact of actions on system operations.
- Diagnoses deviations in the function of a system/ organization.
- Takes necessary action to correct performance.

Improves and Designs Systems

- Makes suggestions to modify existing systems to improve products or services.
- Develops new or alternative systems.

Technology

Selects Technology

- Judges which set of procedures, tools, or machines, including computers and their programs, will produce the desired results.

Applies Technology to Task

- Understands the overall intent and the proper procedures for setting up and operating machines, including computers and their programming systems.

Maintains and Troubleshoots Technology

- Prevents, identifies, or solves problems in machines, computers, and other technologies.

SCANS Foundation Skills and Qualities

Basic Skills

Reading

- Locates, understands, and interprets written information in prose and documents—including manuals, graphs, and schedules—to perform tasks.
- Learns from text by determining the main idea or essential message.
- Identifies relevant details, facts, and specifications.
- Infers or locates the meaning of unknown or technical vocabulary.
- Judges the accuracy, appropriateness, style, and plausibility of reports, proposals, or theories of other writers.

Writing

- Communicates thoughts, ideas, information, and messages in writing.
- Records information completely and accurately.
- Composes and creates documents such as letters, directions, manuals, reports, proposals, graphs, and flow charts.
- Uses language, style, organization, and format appropriate to the subject matter, purpose, and audience.
- Includes supporting documentation and attends to level of detail.
- Checks, edits, and revises for correct information, appropriate emphasis, form, grammar, spelling, and punctuation.

Arithmetic

- Performs basic computations.
- Uses basic numerical concepts such as whole numbers and percentages in practical situations.
- Makes reasonable estimates of arithmetic results without a calculator.
- Uses tables, graphs, diagrams, and charts to obtain or convey quantitative information.

Mathematics

- Approaches practical problems by choosing appropriately from a variety of mathematical techniques.
- Uses quantitative data to construct logical explanations for real-world situations.
- Expresses mathematical ideas and concepts orally and in writing.
- Understands the role of chance in the occurrence and prediction of events.

Listening

- Receives, attends to, interprets, and responds to verbal messages and other cues such as body language in ways that are appropriate to the purpose; for example, to comprehend, to learn, to critically evaluate, to appreciate, or to support the speaker.

Speaking

- Organizes ideas and communicates oral messages appropriate to listeners and situations.
- Participates in conversation, discussion, and group presentations.
- Selects an appropriate medium for conveying a message.
- Uses verbal language and other cues such as body language appropriate in style, tone, and level of complexity to the audience and the occasion.
- Speaks clearly and communicates a message.
- Understands and responds to listener feedback.
- Asks questions when needed.

Thinking Skills

Creative Thinking

- Uses imagination freely.
- Combines ideas or information in new ways.
- Makes connections between seemingly unrelated ideas.
- Reshapes goals in ways that reveal new possibilities.

- For example, uses logic to draw conclusions from available information, extracts rules or principles from a set of objects or written text, applies rules and principles to a new situation, or determines which conclusions are correct when given a set of facts and a set of conclusions.

Personal Qualities

Responsibility

- Exerts a high level of effort and perseverance toward goal attainment.
- Works hard to become excellent at doing tasks by setting high standards, paying attention to details, working well, and displaying a high level of concentration even when assigned an unpleasant task.
- Displays high standards of attendance, punctuality, enthusiasm, vitality, and optimism in approaching and completing tasks.

Self-Esteem

- Believes in own self-worth and maintains a positive view of self.
- Demonstrates knowledge of own skills and abilities.
- Is aware of impact on others.
- Knows own emotional capacity and needs and how to address them.

Sociability

- Demonstrates understanding, friendliness, adaptability, empathy, and politeness in new and ongoing group settings.
- Asserts self in familiar and unfamiliar social situations.
- Relates well to others; responds appropriately as the situation requires.
- Takes an interest in what others say and do.

Decision Making

- Specifies goals and constraints.
- Generates alternatives.
- Considers risks.
- Evaluates alternatives.
- Chooses best alternatives.

Problem Solving

- Recognizes that a problem exists (i.e., there is a discrepancy between what is and what should or could be).
- Identifies possible reasons for the discrepancy.
- Devises and implements a plan of action to resolve discrepancy.
- Evaluates and monitors progress.
- Revises plans as indicated by findings.

Seeing Things in the Mind's Eye

- Organizes and processes symbols, pictures, graphs, objects, or other information.
- For example, sees a building from a blueprint, a system's operation from schematics, the flow of work activities from narrative descriptions, or the taste of food from reading a recipe.

Knowing How to Learn

- Recognizes and can use learning techniques to apply and adapt new knowledge and skills in both familiar and changing situations.
- For example, is aware of learning tools such as personal learning styles (visual, aural, etc.); formal learning strategies (notetaking or clustering items that share some characteristics); and informal learning strategies (awareness of unidentified false assumptions that may lead to faulty conclusions).

Reasoning

- Discovers a rule or principle underlying the relationships between two or more objects and applies it in solving a problem.

About Vocational-Academic Integration

About Vocational-Academic Integration

Words have an amazing power to distract. If you were to read a great many books and articles about the blending of academic and vocational subjects these days, you would see many different terms—***applied academics*** and ***vocational-academic integration*** and ***interdisciplinary instruction*** and ***correlated instruction***—and many different definitions of those terms. It's easy to get caught up in debating terms and to divert your attention from what is most important: improving instruction for students.

The integration Continuum

For the purposes of this document, let's consider a model that is a continuum. The continuum does ***not*** differentiate between good and bad instruction. Rather, it differentiates, in degrees, between good traditional instruction that serves some students well ***and*** increasingly more integrated instruction that serves most students more effectively.

The integration continuum differentiates, in degrees, between good traditional instruction that serves some students well and increasingly more integrated instruction that serves most students more effectively.

- In the stereotypical ***traditional model***, we find each individual teacher working alone in the classroom, teaching only his or her assigned subject in isolation. If the teacher is enthusiastic, knowledgeable, and creative, some students will thrive in this environment.
- At the ***lowest level of the integrated model***, we find those same individual teachers working alone but trying very hard to relate the subject matter to the real world of life and work. They also try to incorporate hands-on activities requiring students to apply what they have learned.
- The ***next level*** moves those teachers out of isolation into varying levels of cooperation and collaboration:
  - ✓ Planning occasional joint activities
  - ✓ Utilizing team teaching
  - ✓ Aligning curricula
- The ***top level*** involves total interdisciplinary teaming in which teachers and instruction are no longer isolated. Instead, they all are focusing their efforts on a major project or theme.

In recent years, researchers have been looking at various models of integration. Two notable efforts have been spearheaded by the National Center for Research in Vocational Education (NCRVE) at Berkeley and the Southern Regional Education Board (SREB). The publications from both NCRVE and SREB (see reference list at the end of this section) are full of exciting examples of what happens in schools that adopt—and truly support—an integrated model.

NCRVE Models

Most of the NCRVE publications on integration focus on eight models:

1. Vocational Teachers Introduce Academic Competencies into Vocational Courses
2. Vocational and Academic Teachers Collaborate to Enhance Academic Competencies in Vocational Classes
3. Academic Teachers Enhance the Vocational Relevance of the Academic Curriculum
4. Curriculum in Both Vocational and Academic Courses Is Modified and Aligned
5. Senior Projects (seniors replace electives with a project)
6. The Academy Model (school-within-a-school)
7. Occupational High Schools and Magnet Schools (in which all teachers—academic and vocational—are assigned to the same facility to facilitate collaboration and course alignment)
8. Occupational Clusters, Career Paths, and Occupational Majors (in which all teachers—vocational and academic—belong to occupational clusters rather than, or in addition to, conventional departments)

SREB Model

The SREB model is in the form of case studies of successful practices derived from a program called ***High Schools That Work***. This program was established by the SREB-State Vocational Education Consortium, a partnership of states, school systems, and school sites (450 sites in 21 states at the time of this writing). According to the High Schools That Work Homepage on the Internet, the program is based on the belief that students in general and vocational programs of study can master complex academic and technical concepts if schools create an environment that encourages students to make the effort to succeed.

High Schools That Work Website

<http://www.praxis.net/~bhs/hstw.html>

The High Schools That Work program has two major goals:

- To increase the mathematics, science, communication, problem—solving, and technical achievement and the application of learning for career—bound students to the national average of all students.
- To blend the essential content of traditional college preparatory studies—mathematics, science, and language arts—with quality vocational and technical studies by creating conditions that support school leaders, teachers, and counselors in carrying out the following ***key practices***.

High Schools That Work—Key Practices

- Setting higher expectations and getting career-bound students to meet them.
- Increasing access to challenging vocational and technical studies, with a major emphasis on using high-level mathematics, science, language arts, and problem-solving skills in the context of modern workplace practices and in preparation for continued learning.
- Increasing access to academic studies that teach the essential concepts from the college preparatory curriculum through functional and applied strategies that enable students to see the relationship between course content and future roles they envision for themselves.
- Having students complete a challenging program of study with an upgraded academic core and a major. An upgraded academic core includes at least four years of college preparatory English and three years each of mathematics and science, with at least two years in each area equivalent in content to courses offered in the college preparatory program. The major includes at least four Carnegie units in a career or academic major and two Carnegie units in related technical core courses.
- Providing students with access to a structured system of work-based and high-status school-based learning—high school and postsecondary—collaboratively planned by educators, employers, and workers and resulting in an industry-recognized credential and employment in a career pathway.
- Having an organizational structure and schedule enabling academic and vocational teachers to have the time to plan and provide integrated instruction aimed at teaching high-status academic and technical content.
- Having each student actively engaged in the learning process.
- Involving each student and his/her parent(s) in a career guidance and individualized advising system aimed at ensuring the completion of an accelerated program of study with a career or academic major.
- Providing a structured system of extra help to enable career-bound students to successfully complete an accelerated program of study that includes high-level academic content and a major.
- Using student assessment and program evaluation data to continuously improve curriculum, instruction, school climate, organization, and management to advance student learning.

Some Cautions

Before we look at our preferred model in greater detail, two cautions should be mentioned.

Caution One: First comes knowledge, then comes application. Students cannot bring their knowledge and problem-solving skills to bear on a problem or theme unless they have first acquired some knowledge and problem-solving skills. You cannot simply devise fun hands-on activities to keep students active and happy and expect achievement of established learning objectives to occur. Learning involves rigor. Activities must be structured to provide application of concepts that have been ***taught*** or to lead to desired ***discoveries***.

This relates to an issue much in the professional literature these days. There was concern in the recent past that students lacked self-esteem, so units and courses in self-esteem were developed and taught. But, asked some of the country's leaders and thinkers, how can you teach self-esteem in a vacuum, separate from achievement? Self-esteem, they say, is earned, not bestowed.

Thus it is with problem solving. To solve problems, student need first to ***work*** to learn basics. Then, and only then, can they apply those basics to the solution of problems.

⚠ ***Caution Two: Don't water down the content.*** Regardless of what you call the approach (applied academics, vocational-academic integration, etc.), the content must not be diluted. As is made very clear in SREB's key practices, all students—both vocational/tech prep and college prep—need to graduate with the skills required for whatever step comes next. Whether the next step is enrollment at two-year or four-year educational institutions, employment in existing enterprises, development of their own entrepreneurial enterprises, or some other endeavor, students need certain skills. Watered-down academics do not provide a passport to success for any of those options.

For example, if you peruse catalogs of texts from various publishers, you will find the tales of Shakespeare written using "controlled vocabulary." In other words, the basic plot line is provided using very simplified language. Is that Shakespeare? No, it is not. It's like serving a BLT—but without bacon and tomato.

Yes, you need to start instruction at a level that is realistic for students' abilities. But if Shakespeare is part of the curriculum, then the teacher's job is to design activities that will help students deal with the language as is. (Some Ohio teachers, for example, have students work in teams to translate passages using a glossary and then share the results of their efforts.) It is also the teacher's job to help them discover why Shakespeare is still relevant to their lives today.

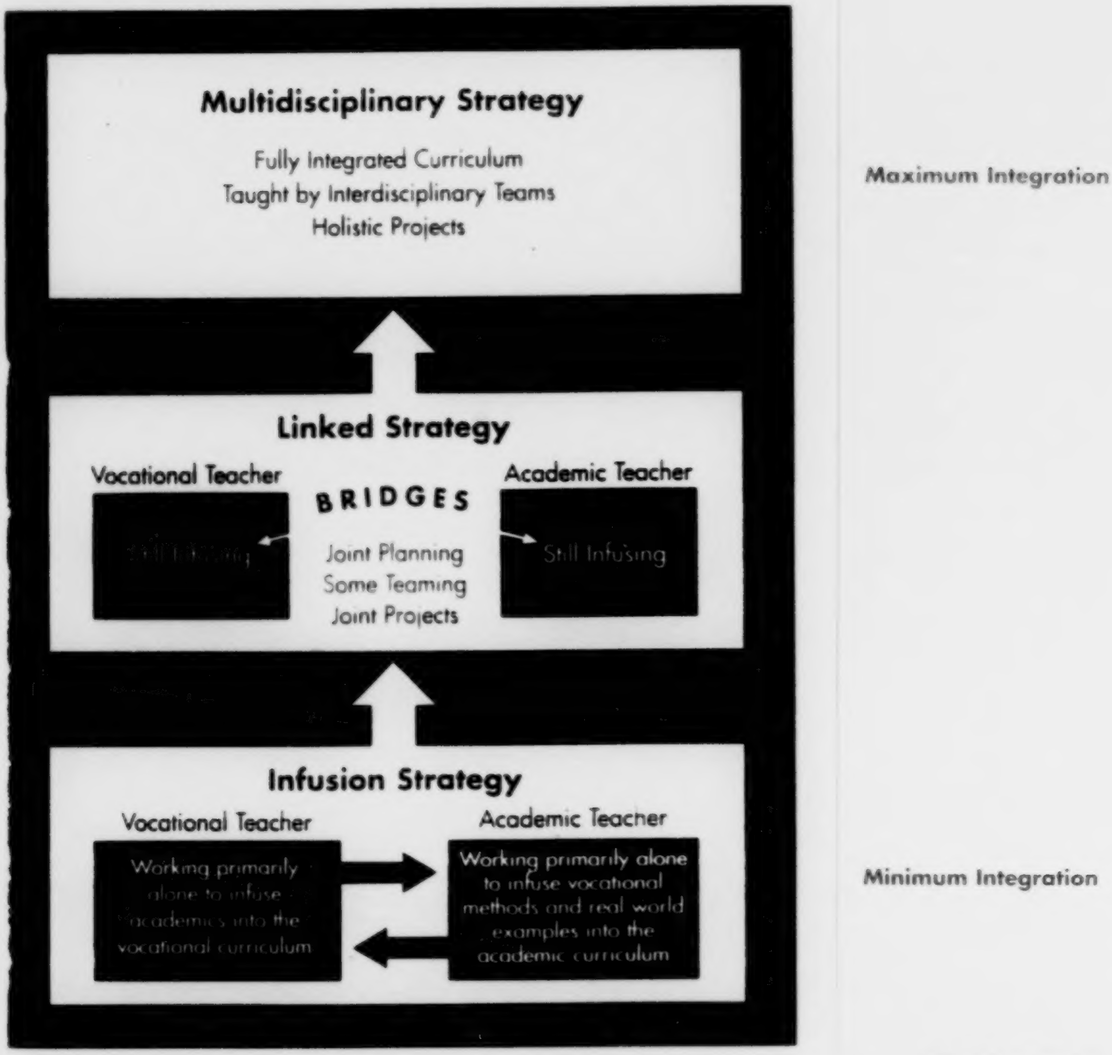
What should be different about applied academics courses is not the level of rigor and the challenge of the content, but how that content is taught.

What should be different about ***applied*** academics courses is ***not*** the level of rigor and the challenge of the content. What is different is ***how*** that content is taught: (1) in a hands-on applied manner and (2) with ties to the real world (life skills, occupational content) to the extent possible. Such an approach is more effective not only with vocational/tech prep students but with many college prep students as well.

Work SITE Tri-Level Model

A simpler model for our purposes—one consistent with the NCRVE and SREB models and particularly responsive to teachers' concerns—is found in *Integrating Curriculum*, developed by Feichtner et al. for School Restructuring Support Associates (1994). The authors describe three levels of integration: the ***infusion*** strategy, the ***linked*** strategy, and the ***multidisciplinary*** strategy.

Our model (based on the Feichtner model) is shown graphically below and described in detail in the remainder of this section.


Multidisciplinary Strategy
Fully Integrated Curriculum
Taught by Interdisciplinary Teams
Holistic Projects
Maximum Integration
Linked Strategy
Vocational Teacher
Still Infusing
BRIDGES
Joint Planning
Some Teaming
Joint Projects
Academic Teacher
Still Infusing
Infusion Strategy
Vocational Teacher
Working primarily alone to infuse academics into the vocational curriculum
Academic Teacher
Working primarily alone to infuse vocational methods and real world examples into the academic curriculum
Minimum Integration

If you are a vocational teacher . . .

Infusion Strategy: Applied But Separate

If you are a vocational teacher, at the Infusion level you are reinforcing the use of academics in your vocational instruction:

- You have students use the academic skills as they would on the job: orally communicating directions to another student, writing up job orders, calculating customer billings.
- You are building problem solving and decision making into classroom activities so that when students leave the program they can operate on their own, without teacher direction.
- You are relating your instruction to the real world of work and simulating that environment to the greatest extent possible.

Formulas for Success

The U.S. Department of Labor offers the following ideas for incorporating job-related elements into the at-school experience in their publication, *School-to-Work Connections: Formulas for Success* (1992, p. 13):

- Involve employers in curriculum development and evaluation to ensure that content, expectations, examples, and standards reflect actual worksite experiences.
- Create classroom lessons that reflect the demands of the workplace and convey specific on-the-job performance requirements to students.
- Group various competencies into clusters that are associated with job-specific tasks, and build manageable, interdisciplinary learning activities around the tasks.
- Emphasize demonstrations, performance modeling, and supervisor coaching as the primary means of teaching students.
- Test students in ways that measure such job-specific criteria as performance quality, production rates, safety, customer satisfaction, and manufacturer's specifications.
- Personalize instruction as much as possible. Develop individual learning contracts for training; work in and with small teams; provide support services on a basis that resembles "case management."

- Design learning tasks to reflect and reinforce work tasks. Include basic skills and employability skills in the same process.
- Structure lessons so that students *learn by doing*. Academic lessons should support work-related learning-by-doing rather than the reverse.
- Express lesson assignments as "Work Orders" reflecting those used in industry.
- Emphasize quality and productivity by applying reasonable pressure on students to perform tasks correctly and on time—as determined by industry standards.
- Encourage students to work in teams to complete learning assignments. Be sure to match experienced students with less-experienced students.
- Use actual worksite materials (manuals, installation instructions, safety materials, forms, tools, etc.) as part of routine lesson content.
- Issue supplies, tools, and equipment in a way similar to that of the worksite. Use a work-based requisition process for issuing materials.
- Organize the training area like the worksite for whatever industry you train for. Explicitly discuss the work climate.
- Whenever possible, use real products and "customer relations" between student and customer as part of learning.
- Sustain instruction patterns between instructor and student that mimic those of the worksite (supervisor and worker) in terms of formality, expectations, discipline, and responsibilities.

Bridging the Gap

Note, however, that you ***can't*** reinforce exactly what's going on ***now*** in the academic classes if you have no contact with those classes. So another thing you can do is reach out a friendly hand to the academic teachers who teach your students. For example:

- Invite them into your classroom and laboratory.
- Talk to them in the teacher's lounge.
- Sit with them at football games.
- Provide them with copies of the texts you use.
- Invite them to participate in meetings of your program's advisory committee or student vocational organization activities.
- Share with them relevant articles from the occupational journals you read.

If you have a problem with this—if you think that you know and can provide all the academics your kids need—then you may need to work on your attitude. A student with minimal mathematics, science, and communication skills will not be prepared for the ***changing*** world of work. Today's world requires lifelong learning. Students cannot, for example, learn to use one particular computer and software package and expect that exposure to serve them for a lifetime. Those who will succeed and advance on the job are those who can think and grow. To develop professionally, they need academic skills. Workplace literacy programs are thriving today for that very reason—too many workers do not have sufficient reading, writing, mathematics, and science skills to participate in the training required for using new equipment and technology.

Just as you are a specialist--an expert--so are the academic teachers. Support each other, and the sum will be greater than its parts.

Higher-level academic skills also prepare students for required life skills: participating productively as a citizen; managing home and bills and taxes; identifying and pursuing interesting hobbies and leisure activities.

Just as you are a specialist—an expert—so are the academic teachers. Support each other, and the sum will indeed be greater than its parts.

STOP

But wait! If you are an applied academics teacher, did you skip the paragraphs above that pertained to the vocational teacher because they "weren't relevant to your needs"? If so, go back and read them now. If you are a vocational teacher, don't stop reading now just because the next paragraphs are addressed to applied academics teachers. It's easy to blame the administration for all the barriers to integration (no time, separate facilities, etc.), but the ability to integrate also rests on each teacher's willingness to step outside his/her own specialty and consider the rest of the world. This is Rule #1 on the road to integration.

If you are an applied academics teacher . . .

If you are an applied academics teacher, at the Infusion level you are trying to apply your content to an occupational area about which you may know a great deal, a little, or nothing. What can you do when you don't know anything about the occupational content and you don't have easy or regular access to the vocational teacher? Actually, there are lots of things you can do.

Provide a Work-Like Setting

The ideas suggested by the U.S. Department of Labor for vocational teachers (see pp. 24-25) also apply, in a sense, to academic teachers. That is, if you want to make instruction more real and relevant, then you need to provide a work-like setting. Here's how:

- Focus less on "concocted" educational experiences, and spend more time devising active and "real" learning experiences for students.
- Provide ample opportunities for students to work in teams, as well as individually, and to "make meaning" with their academic skills.
- ***Teach*** less and focus more on making it possible for students to ***learn***.

Visit Job Sites

The "Connecting" component of Ohio's Work SITE Learning Model is a model for teacher externships. Through this component, teaching teams made up of a vocational teacher and his or her academic counterparts visit area businesses, industries, and community-based organizations to observe and discuss with employees how academics are used on the job. Such activities can help you identify relevant academic content and ways in which to tie that content to the workplace within your academic instruction.

If this option is not available to you, you may be able to find alternatives. For example, if you are teaching science to students in a welding program, you may know someone who is a welder, who would be willing to help you.

Another source for job site visits is the advisory or craft committee for the vocational program. Such committees are made up of local employers who, as their name suggests, serve in an advisory capacity for the vocational program. They may review curricula, judge contests, donate equipment, provide co-op work opportunities, serve as guest speakers, and the like. If you are willing to spend the time, members of these committees might happily provide you with a Saturday on-the-job experience.

Review the Relevant OCAPs

Excerpts from the Precision Machining Technologies OCAP are provided at the end of this document (following p. 210).

Vocational instruction in Ohio is structured using Occupational Competency Analysis Profiles. Each OCAP covers an occupational area (e.g., electronics). OCAPs are employer-verified competency lists, which evolve from a job analysis process involving business, industry, labor, and community agency representatives from throughout Ohio.

Each OCAP identifies the occupational, academic, and employability skills (or *competencies*) needed to enter a given occupation or occupational area. The OCAP clusters those competencies into broader ***units*** and details the knowledge, skills, and attitudes (*competency builders*) needed to perform each competency.

Within the competency list are two levels of items: core and advancing.

- *Core items*, which are essential for entry-level employment, are required to be taught and are the basis for questions on the Ohio Vocational Competency Assessment (OVCA).
- *Advancing items* are those needed to advance in a given occupation.

School districts—working with local advisory committees—may add as many units, competencies, and/or competency builders as desired to reflect local employment needs, trends, and specialties.

The inclusion of state-identified academic skills in each OCAP document indicates that these skills are indeed important for vocational students. Following a review of those academic skills, ***panels of expert workers*** have identified those that are of particular importance for students in that particular occupational area. The Work Keys Job Profiling levels identified in each OCAP document provide another marker for academic achievement needed in the given occupation. And finally, the specific lists of duties, competencies, and competency builders listed for the occupation and for employability include many academic skills, either stated or implied.

Thus, the OCAP document provides an important frame of reference for your curriculum planning. OCAPs start with what students need to ***do*** on the job (competencies) and then identify the knowledge, skills, and attitudes (competency builders) needed to perform those competencies. This structure has application for the academic classroom as well. Applied academics teachers need to focus instruction—at least in part—on the ***actual tasks*** students must perform in the work world or in life (write a convincing memo, calculate the amount of materials needed to perform a particular job, solve problems on-site using knowledge of scientific principles) and then teach the English, mathematics, or science skills and concepts as they are needed in relation to the tasks.

Applied academics teachers need to focus instruction on the actual tasks students must perform in the work world or in life and then teach the academic skills and concepts as they are needed in relation to those tasks.

For example, have students complete a mileage reimbursement form from an actual job. Teach the mathematics in relation to that task. Better still, help them discover the principles themselves—help them to think mathematically, to define and answer their own questions. Bring in ethics: Would it be right to charge the company mileage for a side trip to run some errands?

Make Contact with Your Students' Vocational Teachers

If you have never met your occupational counterpart, take the initiative. Feedback from academic and vocational teachers indicates that there are some barriers typical to any situation involving "us" and "them." Vocational teachers who came to teaching straight from industry say that the academics look down their noses at them because they took an alternative route to certification. Academic teachers say that vocational teachers look down their noses at them because of their lack of technical know-how. On the other hand, teachers who participated in integrated teaching teams as part of the Work SITE project found it easy to work together and developed mutual respect rather quickly.

Working together is mostly a matter of taking that first step and turning a stranger into a friend. Be creative in your attempts to make contact. A little contact can go a long way.

It's mostly a matter of taking that first step and turning a stranger into a friend. Be creative in your attempts to make contact. You know best what would feel comfortable for you and what the limits and possibilities of your particular situation are. Some possibilities:

- ***Let students be the messenger.*** Consider making comments in class that show respect for students' vocational instructors; such messages will likely get back to those teachers. Or, when students ask questions that cross over into occupational content, ask them to get the answer from their vocational teacher and then explain it to you during the next class session. (But don't overdo this. You want to show that you value the teacher's expertise without overburdening him or her with questions coming from your class.)

- ***Set up a shared bulletin board.*** If you share a teacher's lounge but not a common planning time, try setting up a bulletin board where you can communicate. A mathematics teacher could, for example, post a note such as the following: "About to teach formulas involving pi. Need examples of how that would be used in welding." Or teachers could post the key concepts they're covering with each class that week in order to promote more correlation between classes.
- ***Set up meetings.*** Identify times when you can meet with the vocational teacher. At the very minimum, you could arrange to visit the vocational classroom or lab occasionally during one of your planning periods. Or perhaps the two of you can pick a day when you could meet there for an hour after school to discuss your mutual students. If possible, arrange to have someone—fellow teacher, department head, curriculum specialist—cover one of your classes for a period so that you can visit the vocational class while your students are there. Similarly, invite the vocational teacher to visit your classroom when you are teaching his or her students. With the vocational teacher's permission (or at his/her invitation), attend meetings of the program's advisory or craft committee.

  A teaching team that participated in the Ideabook pilot test took advantage of the fact that advisory committee meetings for three programs were scheduled on the same night as Parent-Teacher Conferences when all teachers would be in attendance. Academic teachers with (unfortunately) few parents to meet with were able to attend portions of the advisory committee meetings. They explained their curricula and, in turn, got some ideas about what employers expect of workers in the area of academics. Both academic teachers and advisory committee members were pleased to have had this chance for interaction.

Belmont-Harrison JVSD Teaching Team

Jim Davis, Precision Machining

Sophie Garrity, Applied Science

- ***Seize the moment.*** Identify a specific question you need help with, and pick up the phone. Or leave a note in the vocational teacher's school mailbox. Or send e-mail if that's an option. Don't impose, just open up the door to future communication.

Even if your schedule and location are not conducive to such activities, don't give up. A little contact can go a long way. If you can't meet very often, just getting materials from the vocational program can help you better relate your instruction to students' occupational interests.

Read Occupational Materials

Depending on your aptitudes and willingness to spend extra time, this could be a major undertaking or a casual and occasional activity. An applied science teacher, for example, who expects to be teaching electronics students year after year and who is interested in electronics might choose to do some heavy reading in the area. But an applied communications teacher who works with students from different occupational programs each year and who has little interest in electronics might take a lighter approach.

You need to be realistic about this. You were hired to be an academic specialist, not a vocational teacher, but a little effort can go a long way. It's sort of like buying a phrase book before visiting a foreign country. It's amazing how warmly you are received when you make an attempt to say simple things like *hello* and *thank you* in the native language.

Do you know what jobs students can get by training in the occupational area? Do you know what those jobs pay? If not, you should spend a little time looking at a general reference for occupational information, such as the *Occupational Outlook Handbook* or the *Dictionary of Occupational Titles* (DOT).

O*NET Website
<http://www.doleta.gov/programs/onet>

An online source for the future in this area is the Occupational Information Network. O*NET is being designed to replace the DOT and to provide the flexibility to capture rapidly changing job requirements now and into the 21st century. When it is fully developed, O*NET's developers say that it will be a comprehensive database that identifies and describes occupations, worker skills, knowledges, abilities, and workplace requirements for jobs across the country in all sectors of the economy.

A teaching team in the Ideabook pilot test developed a plan for using tech prep inservice meetings to provide home school academic teachers with academic information relevant to one occupation. The plans call for holding separate meetings for teachers from each academic area—mathematics, English, and science. At these meetings, academic teachers would receive copies of *Applied Academic and Workplace Skills for Automobile Technicians.* This document, produced by the National Automotive Technicians Education Foundation (NATEF), lists the academic skills needed by auto technicians and real-world applications for those skills. Vocational teachers would be on hand at these meetings to discuss the tasks and answer any questions.

Tri-Star Career Compact/
Minster High School
Teaching Team

Harry McPheron,
Automotive Technology

Jack Albers, Tech-Prep
Coordinator

Pam Grew, Integrated
Science

Draw on Your Students' Developing Expertise

This may be the most effective strategy you have at your disposal because it not only provides you with the occupational content you need but it also involves students actively, helps them process what they know, and develops their self-esteem. Too often teachers—particularly new teachers—are afraid to let students know there's anything they don't know. They're afraid that if they let down their guard and admit their ignorance, students will not respect them.

But in the workplace, it is important to know when to consult others who have expertise you lack. Bluffing on the job can be dangerous. As a teacher, you can model an important workplace skill if you sometimes step into the role of learner and let students teach you about their occupational skills. Not only will you not lose their respect, on the contrary, students will likely respect your cleverness in recognizing how clever they are. Furthermore, you will be modeling the necessity of lifelong learning. Everyone is sometimes a teacher and sometimes a learner in this world—except in America's traditional classrooms.

Everyone is sometimes a teacher and sometimes a learner.

There are many ways to use student expertise as a resource. For example:

- ***Workplace scenarios.*** The Ideas section of this document provides a number of activities in which students develop workplace scenarios that can form the basis for a variety of classroom activities.
- ***Student presentations.*** Instead of having students in applied communications classes make the typical oral presentations on "What I did on my summer vacation," consider having them do presentations or demonstrations on skills they've learned in their vocational classes. To ensure that students stay engaged while others present (good practice for the listening skills needed on the job), have them complete evaluation forms, rating the presenter's performance against established criteria.

  Such presentations will teach you a lot about the occupation your students are studying, and they will teach students how to communicate effectively. Their assignment is to explain an occupational concept or demonstrate an occupational skill so that you—an occupational "illiterate"—can understand. If at the end you still don't understand, they have not communicated effectively.

  Is this a waste of their time? Certainly not. Being able to explain a task clearly to a coworker is a skill they will likely need on the job. Furthermore, studies have shown that when students tutor others, it is the ***one doing the tutoring*** who benefits most. In order to teach someone else, you need to organize your own knowledge, which strengthens your understanding and cements the knowledge more firmly in your mental database.
- ***Student discussions.*** When you start a unit on a particular concept, start with student discussion. In a mathematics or science class, for example, begin the unit by asking what students already know about the concept to be addressed? Where have they encountered it in their vocational classes or outside of school? If the concept sounds foreign to them, you may need to prompt them to discover relevant examples. Then use the examples—perhaps full-blown student-developed scenarios—as the foundation for instruction. Or give students assignments to complete in the vocational lab (e.g., measure the cylinder bore and bring the numbers back to me tomorrow).

Using the expertise of students may be particularly helpful for the academic teacher who has students from many vocational areas in a single class. Correlation is more difficult when there are multiple areas to deal with, and it is unlikely that the academic teacher will be able to develop expertise across all areas. Students in this situation can profit from the expertise of their peers. For example, the business student who sees a demonstration by an auto mechanics student on how to change the oil in a car can use that knowledge, if only to talk to his or her mechanic more intelligently.

One of the teaching teams in the Ideabook pilot test used teacher exchanges to increase the applied academic teacher's knowledge of welding—with students serving as the "experts" in the vocational lab. As originally planned, the applied academic teacher would exchange positions with the welding teacher for one class period per week over an 8- to 10-week time span. The administrator was concerned about whether students would be learning in both classes if this were to occur—a valid concern.

EHOVE Career Center Teaching Team

Chuck Livermore, Welding

Brett Dickey, Applied Math/Science

Jerry Mahl, Applied Science

To ensure that students were in fact in good hands, the following approach was used:

- Students were given specific lab assignments by the lab instructor—assignments involving skills they had already performed safely and satisfactorily under the supervision of the welding instructor.
- The two instructors met in the lab to discuss lab policies and procedures. The welding teacher pointed out areas where problems could occur and how to prevent or handle them. They also met for 15-20 minutes before each exchange to discuss specific concepts that might be observed in the lab.
- The applied academics teacher observed student performance, while ensuring that all lab policies and procedures—particularly those related to safety—were followed. The teacher also ensured that relevant academic skills were applied and reinforced.

- The welding students taught the applied academics instructor about the welding procedures and techniques they were using (e.g., amperage settings on the machine and their effect on weld penetration and the strength of the weld). This reinforced for the students some concepts from the applied classes and enhanced their self-image and their ability to communicate.
- The welding instructor used the academic class time to work with the juniors on blueprint reading and design.

The team has the following recommendations for improving this activity in the future:

- Plan the exchanges when students have already started on projects in the vocational lab—after the vocational instructor has had time to work with them a bit and answer any questions they may have.
- Allow a minimum of 5 days for exchanges, but an exchange over 10-15 days is preferable. And follow a continuous daily schedule, rather than exchanging classes one day a week for 5 weeks. These practices would make it easier to identify the logical progression and continuity of the concepts being observed.

Linked Strategy: Collaboration and Cooperation

Collaboration begins with attitude.

One Ohio applied mathematics teacher—who teaches horticulture students in collaboration with their other teachers—suggests that a key to his success is that he thinks and talks in terms of "my horticulture class," not "my juniors now in mathematics class." True collaboration begins with this kind of mindset. Students in a vocational program have, in essence, selected a major. Regardless of which class they are in, they are auto mechanics or welding or electronics students. When the applied academics teacher operates from that viewpoint as well, students are more likely to feel that the teacher has a genuine desire to teach them (i.e., wouldn't rather be off teaching "real" academics to college prep students). This perception, in turn, may help students to accept academics as relevant.

Joint Planning

At the Linked level, vocational and academic teachers work together. This may mean that an applied communications teacher meets periodically with the vocational teacher to plan jointly. Joint planning might also involve the vocational teacher and ***all*** applied academics teachers—mathematics, science, and communications. Such planning can help ensure that their instruction dovetails in a general way and that each teacher reinforces what the other has taught. As part of joint planning, the vocational teacher can identify occupational materials and authentic materials from the job that can be used in academic classes.

A teaching team that participated in the Ideabook pilot test developed a plan for securing some common planning time. They were eager to plan jointly, but the schedule just did not allow for that to happen. In looking at options, they wondered whether they could use inservice time for planning. (The district requires teachers to obtain 12 hours of professional development outside school hours.) They spent time building a case for this plan, focusing on the benefits to students if teachers coordinated their curricula and had time to develop a team feeling. As they planned, they became more and more enthusiastic, and all kinds of possibilities came to mind. When they presented their idea to their supervisor, he shared their enthusiasm. The team was pleased that their idea was so well received, and they began to make plans for implementing their idea during the next school year.

Pioneer CTC Teaching Team

Rick Stephens, Home Remodeling/Carpentry

Bonnie McQuown, Applied Communications

Lynn Cooke, Applied Science

Like the Pioneer CTC teaching team, the team from Springfield-Clark County JVS presented their associate director with plans they had developed for securing common planning time. They presented a number of options (e.g., paid extended time in summer or extended day, one day a month of coordination time, shortened instructional periods). However, at present, using their periodic professional days for joint activities was the only realistic option. They proposed using these days in two ways: (1) all three teachers secure a professional day and use it to develop joint plans and coordinate instruction; and (2) one teacher secures a professional day and uses it to be part of his/her counterpart's classes for the day (e.g., the applied

Springfield-Clark County JVS Teaching Team

George Combs, HVAC

Melissa Nelson, Applied Mathematics

Mike Pottmeyer, Applied Science

mathematics teacher spends the day in the HVAC classes). The team was allotted two professional days initially for the development of joint plans.

The Belmont-Harrison JVSD teaching team sought and received permission to have an inservice activity in which academic-vocational teams would have the chance to develop short, integrated lesson plans.

Joint Projects

Plans may also involve student activities or projects that are guided and graded by both the academic and vocational teachers. For example, students could work with the vocational teacher to pick a topic to research. The applied communications teacher could then work with students on the skills needed to conduct the research and develop a report (library skills, notetaking, outlining, bibliographical form, etc.). Mathematics and science teachers could serve as advisors when an aspect of the research touches on those areas. Once completed, the reports could be graded by both the applied communications teacher (for its adherence to the criteria for a good research report) and by the vocational teacher (for its technical accuracy and worth).

The Pioneer CTC teaching team developed the following plan for a joint project focused on the building of a house addition in home remodeling classes:

- Science Class: Students will study weight distribution and placement of joists for strength; types of materials needed for durability, weather resistance, strength, and product longevity; and insulation choices dependent on R-values required in building the addition.
- Math Class: Students will estimate the materials needed using a Quantity Take-Off sheet; determine how much material will be needed; and calculate the total cost of the project.
- Communications Class: The teacher will guide students through the contents of the contract for the addition, including the materials list, the general conditions, and the specifications. Contractual language will be examined, and students will summarize the articles in the AIA document for residential construction.

- Joint Work: Students will develop a detailed written proposal for the addition, including an introduction, description, options, references, completion date, payment requirements, and final costs. Work on this proposal will occur across classes. An oral presentation to the client will be the final requirement.
- Vocational Class: As actual construction is carried out, the vocational teacher will reinforce the academic skills and concepts learned and stress their importance to a high-quality end product.

One problem the team had to deal with was that students at this school take science only in their junior year, and communications only in their senior year. Their solution was to have students maintain a notebook, *Phases of a Building Project*, in which they keep track of the necessary forms, diagrams, notes, and examples for continuity and clarity over the two years of study.

Team Teaching

Collaboration and cooperation may also move beyond mere planning into team teaching. Teaming can take many forms. Teachers may team teach only occasionally, perhaps to introduce a particular unit. Or, if the school structure allows, they may spend a great deal of time in each other's classes and labs. Ohio teachers who have done this as part of the Work SITE Learning pilot project enthusiastically describe the difference this makes for students—in terms of both learning and attitude. The advantages are numerous:

- Having more than one teacher available allows more individual attention to be given to students.
- Teaming models and strongly underscores the relationship between academic and vocational skills. As mathematics or science concepts surface in the lab, the academic teacher is there to help.
- The applied teacher becomes more occupationally literate and gathers examples with which to illustrate concepts in academic classes.

Building of Administrative Support

Clearly, time and location are key aspects of collaboration. A mutual planning period is a must. Block schedules that give teachers flexibility can make an enormous difference. Assume, for example, that science and electronics are scheduled back to back in the same area of the building, and that each teacher is free during at least part of the other class. Imagine the possibilities! The teachers could serve as "aides" in each other's class. Or they could plan to extend a science lesson into the electronics period, or vice versa, when a particular instructional piece warrants it.

Hint: Approaching an administrator with ideas for overcoming the problems with his/her school is likely to prompt a defensive reaction. It's usually best to focus on how your recommended changes will benefit the school and the students in specific and tangible ways.

If you have trouble moving to the Linked level because of lack of administrative support, a helpful resource is *Integrating Academic and Vocational Education: Guidelines for Secondary School Principals* by Schmidt et al. (Berkeley, CA: NCRVE, 1992). Giving your principal a copy or using it to prepare a presentation for that principal could make a difference. The document presents a wealth of good information in a short, punchy style. One section spells out the barriers to integration, and—even more important—suggests reasonable strategies for pulling down those barriers. The various chapters walk the administrator through the steps to integration clearly and simply.

Teaching teams in the pilot test for the Ideabook who sought support for common planning time (as described earlier) reported a very real benefit. Even though they were unable, on short notice, to secure regular, formal common planning periods, they did find administrative support. Administrators were impressed with the teacher collaboration shown, the plans made, the enthusiasm of the teachers, and their focus on the benefits to students. Teachers, in turn, found out the constraints facing the administrators (e.g., how truly complicated the scheduling process is). A foundation was established for increasing options for common planning in the future.

The team from EHOVE Career Center that secured administrative approval for teacher exchanges suggests that it is important to know the "style" of your administrators. Will they be more receptive to a formal written plan, or to an informal face-to-face meeting? How receptive are they to change? If they are not quick to accept changes, consider starting small.

Multidisciplinary Strategy: Fully Integrated Curriculum

The Multidisciplinary level is where the academic-vocational walls come down, both literally and metaphorically. Through a school-within-a-school or cluster structure, students are assigned to an occupational program taught by a team of teachers—academic and vocational—working together to provide instruction. The academic teacher no longer reports to a department chair in his/her academic area; the vocational teacher no longer reports to a vocational supervisor for his/her area. Instead, a team leader is selected on the basis of leadership skills, and that person's specialty may be vocational or academic. In some integration models at this level, students stay with the same team of teachers for the two or three years of the program.

Schoolwide Projects

In some schools, projects provide the focus for all instruction. At Rindge School of Technical Arts in Cambridge, Massachusetts, for example, all ninth graders are involved in a project called *Cityworks* in which the "text" is the city itself. Students carry out projects related to the city with the coaching of their teachers. In this case, the walls have come down not only between disciplines but also between the school and the community. Tenth graders at Rindge focus on constructing electrical vehicles, and all instruction supports successful completion of that task.

Projects can cross the lines between occupational areas. When a school focuses on a major project, students in different areas can each bring their growing expertise to bear on its completion. Imagine, for example, a school project to turn a vacant lot into a city park. Students in social studies or communications classes could devise surveys to determine what the citizenry would desire in such a park. Students in marketing classes could develop a publicity campaign for the effort. Students in horticulture classes could design and develop the landscaping. And on and on and on. Just as in real life, there would be a role for most specialties in any complex project. And just as in real life, those roles interact.

Three-quarters of the students who train in a particular field never work in that field for a single day once they leave school. And the average American changes jobs seven times in a lifetime. Narrow, job-specific training for entry-level jobs is an anomaly. Broad, industry-wide training is what is needed. . . . Vocational education's greatest strength is not putting kids in jobs, it's its methods.

Larry Rosenstock,
Executive Director
Rindge School of
Technical Arts

Individual Projects

In other schools, it is the senior year that is project-based. The senior project is often an individual activity, providing a capstone experience and forcing each student to apply all that he or she has learned. It is an authentic, real-world project leading to a new discovery or a usable product. Teachers serve as advisors. Students are encouraged to make use of the expertise of their peers on particular aspects of their projects (within reason, of course), just as they would in the real world of work. Often, the culmination of the senior project is a major report and an oral presentation, with individuals from business and industry serving as judges.

School-Based Enterprises

David Cairns, applied mathematics teacher at Warren County Career Center in Lebanon, Ohio, suggests that a laboratory-based, student-operated business (with customer service) can also provide a fully integrated curriculum. In this approach, students rotate on and off the floor to remediate, prepare for proficiency and Work Keys exams, and meet curricular requirements. Applied academics teachers act as supervisors in the laboratory-business, teaming with the vocational instructor and with each other.

Where Do You Go from Here?

You've had a brief look at the three levels of integration: Infusion, Linked, and Multidisciplinary. Which level best describes your present situation? What steps can you realistically take to move to a more integrated approach at that level or to move to the next level? The rest of this document is designed to help you answer these questions.

On the next few pages are listed numerous references that can help you learn more about the process of integration. Many of these are filled with real-life examples of the exciting things schools are doing to integrate instruction. Many present hard data documenting that integration can make a difference, not just in students' attitudes, but in their standardized test scores.

The second section of the Ideabook presents strategies and activities you can use to make academic instruction more integrated, more authentic, more relevant to students' occupational programming. You can use them "as is" or adapt them to your particular situation. Some are related to a specific academic area; some cross disciplinary lines. For example, teaching students to think consciously about the thought processes they use (metacognition) helps them learn how to learn. And you can't modify instruction without modifying the way in which you measure student learning; thus, one "idea" focuses on the use of authentic assessment.

The third section is about the Information Superhighway—the Internet. You'll find information about the World Wide Web, e-mail, newsgroups, and mailing lists (or listservs), and an abundance of Internet addresses that will get a user quickly to the wealth of educational resources available on the Web.

The final section provides a list of curricular resources for applied academics. It's last for a reason. Historically, instruction starts with a textbook. The new teacher is given a text and designs lessons around use of that book, often in just the order it dictates. But we're talking about a different approach to instruction here, one that starts with the skills students need to survive and thrive in life and at work. It starts with authentic tasks. Materials, then, should be selected to support the mastery of those tasks—preferably a wide variety of materials and preferably some that are authentic (i.e., obtained from the world outside the classroom).

Additional References

For more information about academic-vocational integration, consider the following sources:

Allyn & Bacon, Longwood Division
Phone: 800-278-3525
World Wide Web: <http://www.abacon.com>

- ✓ *Interdisciplinary High School Teaching: Strategies for Integrated Learning*

  This guidebook includes ten full-length case studies from real classrooms, plus vignettes and illustrations submitted by hundreds of teachers. Topics include current developments in interdisciplinary and project-based learning, involving multiple intelligences in the learning process, critical thinking, and problem solving. Throughout, the focus is on showing how classroom learning can be invigorated by emphasizing connections between subject areas, the process of learning, and the world of work.

American Vocational Association (AVA) Product Sales
Phone: 800-826-9972; Fax: 703-683-7424

- ✓ *Career Academies: Partnerships for Reconstructing American High Schools*

  Uses examples of thriving academy programs to show how to integrate academic and vocational curricula, raise student ambitions, and increase career options.
- ✓ *How to Integrate the Curricula*

  Presents ten innovative models for curricular integration—tools to help students understand the connections between the things they learn.
- ✓ *Toward Active Learning: Integrating the SCANS Skills into the Curriculum*

  These 71 innovative lesson plans are designed to teach skills valued by industry, like teamwork, designing systems, and maximizing resources. The lesson plans can be used with any discipline and with little advance preparation.

Instructional Materials Laboratory
University of Missouri-Columbia
Phone: 800-669-2465; Fax: 314-882-1992
World Wide Web: <http://iml.coe.missouri.edu>

- ✓ *A Practitioner's Guide to Integrating Academics*

  This how-to manual defines integration, looks at its benefits, examines issues that must be addressed for it to succeed, provides several models for developing integrated instruction, and discusses assessment (of programs, teaching, and student work). Case studies illustrate integration in action and provide helpful tips.

National Center for Research in Vocational Education (NCRVE)
Materials Distribution Center; Western Illinois University
Phone: 800-637-7652; Fax: 309-298-2869
E-mail: <msmds@uxa.ecn.bgu.edu>
World Wide Web (Publications Search Program):
<http://ncrve.berkeley.edu/eg.acgi>

- ✓ *Academic-Career Integration in Magnet High Schools: Assessing the Level of Implementation*
- ✓ *Achieving Integration Through Curriculum Development: Videotape of 11/24/92 Teleconference*
- ✓ *Annotated Resource List: Integration of Academic and Vocational Education*
- ✓ *Assessing the Integration of Academic and Vocational Education: Methods and Questions*
- ✓ *Blurring Academic and Vocational Boundaries: Barriers in the Cultures of Large High Schools*
- ✓ *The Challenge to Change*
- ✓ *Collaborative Efforts Between Vocational and Academic Teachers: Strategies that Facilitate and Hinder the Efforts*
- ✓ *The Cunning Hand, the Cultured Mind: Models for Integrating Vocational and Academic Education*
- ✓ *Examples of Integrated Academic and Vocational Curriculum from High School Academies in the Oakland Unified School District*

✓ *General Education: Vocational and Academic Collaboration*

✓ *Helping Teachers to Understand Their Roles in Integrating Vocational and Academic Education: A Practitioner's Guide*

✓ *Helping Vocational and Academic Teachers Collaborate to Improve Students' Reading and Writing Skills: An Over-Time Inservice Activity*

✓ *Integrating Academic and Vocational Education*

✓ *Integrating Academic and Vocational Education: A Review of the Literature, 1987-1992*

✓ *Integrating Academic and Vocational Education: Guidelines for Assessing a Fuzzy Reform*

✓ *Integrating Academic and Vocational Education: Guidelines for Secondary School Principals*

✓ *Integrating Academic and Vocational Education: Issues in Implementing the Carl Perkins Amendments of 1990*

✓ *Integrating Academic and Vocational Education: Lessons from Eight Early Innovators*

✓ *Integrating Academic and Vocational Studies*

✓ *Integration of Vocational and Academic Education: Theory and Practice*

✓ *Making High Schools Work: Patterns of School Reform and the Integration of Vocational and Academic Education*

✓ *National Roster of Local Practices in the Integration of Vocational and Academic Education*

✓ *New Designs for the Comprehensive High School Videotape*

✓ *Preparing Teachers to Successfully Integrate Vocational and Academic Education: A Case Study Approach*

✓ *Teachers' Roles in the Integration of Vocational and Academic Education*

✓ *Two Worlds: Vocational and Academic Teachers in Comprehensive High Schools*

✓ *Using Professional Development to Facilitate Vocational and Academic Education Integration: A Practitioner's Guide*

✓ *Vocational and Academic Teachers Work Together*

✓ *What Works When Teachers Integrate Vocational and Academic Integration*

Southern Regional Education Board (SREB)
Communications Office
Phone: 404-875-9211, ext. 232; Fax: 404-872-1477

- ✓ *Integrating Vocational and Academic Education Video Package*

  The package contains three 90-minute videos; a guide for facilitators to use in helping teams plan integrated learning activities; and a participant workbook with group activity resource pages, background readings, and examples of integrated learning activities. The video titles: *Exploring Integration, Planning Integrated Learning Approaches,* and *Integrating Mathematics to Advance the Performance of Career-Bound Students.*

- ✓ *Making High Schools Work: Through Integration of Academic and Vocational Education*

  Provides real-life examples illustrating the problems and accomplishments and the practices and strategies of high schools that have effectively integrated academic and vocational education.

- ✓ *Outstanding Practices Series*

  Annual publications, produced since 1991, contain descriptions of successful strategies from *High Schools That Work* sites, with a contact person listed for each site to promote networking.

- ✓ *Teaching for Understanding through Integration of Academic and Technical Education*

  More case studies and descriptions of integrated learning from the *High Schools That Work* sites that have been most successful in advancing student learning through this type of effort.

- ✓ *Workshop Videos*

  Numerous videos of the sessions conducted at *High Schools That Work* Summer Staff Development Conference are available, including *Supporting Academic and Vocational Teachers in Changing the Nature of Teaching and Learning, Integrated Curriculum in the Classroom, Replacing Dumbed-Down English with a Challenging English Curriculum, How Mathematics and Vocational Teachers Are Using Integration Projects to Teach High-Level Mathematical Concepts,* and *Hands-on Materials for Teaching Mathematics and Science.*

Integration Ideas: Activities and Strategies

Integration Ideas: Activities and Strategies

The ideas in this section are intended to "prime your mental pump"—to give you some starting points for thinking about the activities you will develop for your own program. Although the specific examples used to illustrate each of the following ideas may relate to a single academic or vocational area, the ideas are, for the most part, applicable to all applied academics and vocational teachers.

Some "ideas" are in the form of strategies. Teaching thinking strategies and using authentic assessment, for example, are instructional strategies that are gaining wide use in education. They are included here because they are particularly well suited to integrated programs in which activities and materials are authentic and learning is collaborative.

Other ideas lend specific support to the process of integration. Devices are provided that guide you in looking across disciplines and incorporating relevant materials and concepts as you carry out your instructional planning. Lesson plans developed cooperatively by academic-vocational teaching teams are presented. A sampling of interesting integrated classroom activities are described.

As you look through these ideas, remember: This is just the starting point. With your subject-matter expertise and the collaboration of the other teachers who share responsibility for your students, you should be able to go well beyond these ideas (remembering, of course, that Rome wasn't built in a day).

Teach Thinking Strategies

Teaching students to analyze their thought processes can help them learn how to learn. When you were a student, did you ever have one of those golden mathematics teachers who could look at your incorrect answer and tell you exactly ***where*** you went wrong in your calculations—in your thinking? Such information was far more helpful than just knowing that the answer—the product—was wrong.

Monitoring, thinking about, and questioning the way we process information is called metacognition.

We sometimes tend to focus in class on the correct answer or the desired product, but the process used to arrive at that result is equally as important. As learners, students need help in focusing on process—on identifying the process they are using—and learning to use analysis of process to improve performance. By helping students monitor, think about, and question the way they process information—called *metacognition*—we can "help them become more independent learners who can recognize and correct their own processing errors."[1]

Metacognition Techniques

One good way to teach thinking strategies is to model them. As you carry out a process in your teaching, think aloud. Explain what's going on in your head—not just what you're doing but how you're mentally ***deciding*** what to do (and what not to do).

Another way to teach thinking strategies is to involve students in a process and then to stop instruction periodically to ask students to look at what they did, what they experienced, what they felt. "In this way, provided there is a general atmosphere of relaxed alertness and trust, students move to deeper levels of understanding because the experience includes dealing with the impact of the process on themselves, including emotional involvement. . . . Students learn the process not as an abstract concept but in relation to their own thinking and behavior."[2]

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[1] J. W. Philippi, "Developing Instruction for Workforce Literacy Programs" (Springfield, VA: Performance Plus Literacy Consultants, 1989), p. 6.

[2] Excerpted from R. N. Caine and G. Caine, ***Making Connections: Teaching and the Human Brain*** (Alexandria, VA: Association for Supervision and Curriculum Development, 1991), pp. 148, 151, and 169-170. (ED 335 141)

Sample Metacognition Activity

Assume that students in your classes have difficulty locating information on tables or charts or in interpreting that information. Maybe no one ever walked them through the mental processes used to deal with tables. Just saying, "This is a table, and it provides these pieces of information" is not enough for some students. You need to model the whole mental process used. For example:

- Select a table, preferably an authentic one used on the job.
- Give copies of the table to all students.
- Identify the piece of information you want to find using the table.
- Go through the process of finding that information, explaining out loud what you are thinking as well as what you are doing. Do not make any of the "automatic" leaps you usually make as a skilled table reader. Keep it very basic, and spell everything out.

  For example, the exact term or phrase you are looking for may ***not*** be there on the table. You may need to look for a synonym or similar phrase. Tables have headings; do students know about headings? Do they know that a particular symbol can be decoded by looking at the key? Do they know where to find the key?
- Identify another piece of information to find, and repeat the process. Stop periodically in the process, and solicit student input.
- Identify yet another piece of information to find, and let students talk the class through the process.

The next idea—portfolio assessment—includes a large dose of metacognition.

Use Authentic Assessment Tools: Portfolios

Students in programs reflecting the real world will complete many authentic job-related tasks involving reading, writing, speaking, listening, calculation, computation, and critical thinking (e.g., problem solving and decision making). Dated artifacts of all these tasks—drafts, final versions, completed exercises, lab work, projects, performance tests, audio- or videotapes—can be kept in a *working folder* to provide a total record of the learner's work. When special pieces are selected from the folder and moved to another, special folder, then the learner has created a *portfolio*. Pieces can be selected for different reasons: to show representative work, to showcase best or favorite work, or to show progress, for example.

This information on portfolios was adapted from Sandra G. Pritz, Lois G. Harrington, et al., Assess Learner Performance (Columbus, OH: Center on Education and Training for Employment, 1997), pp. 25-27, 30.

Purposes

Having students maintain folders and portfolios is an excellent way to keep the focus on both process and product and to provide a basis for students to review and reflect on their progress as learners in reference to actual work rather than abstract, reductive scores and grades. Unlike material that is "done" once it has been graded, the working folder's contents belong to the learner and can be revisited at any time to be reworked using newly gained skills, increased competence, or fresh insights. This, too, reflects the real world. The portfolio, on the other hand, can serve as a permanent record of achievement.

Folders and portfolios provide a basis for students to review and reflect on their progress as learners in reference to actual work.

But portfolios aren't just a repository of already assessed things; this is an assessment process. The contents of the working folder are used to promote learners' reflection about and assessment of their own work and, perhaps, the work of their peers. Structured assessment activities can be devised related to the ***selection*** of materials for the portfolio. For example:

- Learners can be asked to review the material in their working folder and pick their favorite or best piece and describe, in writing, what they liked about it, what they learned from doing it, and why they consider it their "best" piece.
- Learners can select two analogous final products developed at different points in the program and compare them to identify indicators of progress.

In each case, the written reflections and evaluations become a part of the portfolio, perhaps as a cover page to the documents assessed or in a separate portfolio log. If materials are judged by others (peers, instructor, others outside the program) as part of the selection process, those "judges" should provide narrative reviews as well, and these, too, should become part of the portfolio record.

These activities can be carried out individually, or students can collaborate as partners or in teams. Collaboration can be particularly helpful early in the program. A student might, for example, identify three favorite pieces and find it difficult to choose just one. A "second opinion" from a peer can provide additional insight and evaluative information that can help in making the final decision. Or, a supportive peer can help identify a "best" piece, with some admirable qualities, in the folder of a learner who's not sure anything there is of value.

Grady suggests other questions that can be used to structure students' reviews and assessments of the work in their folders. These were used originally in a writing class, but they could be easily adapted to other tasks:

- Look back over your work for this semester and discuss the strategies you used for creating it. Think about specific essays. Which were easy for you? Which were most difficult? What have you learned about your methods this semester?
- What do you like about your writing? What do you feel are your strengths? Be as specific as you can; cite essays if possible.
- What are you dissatisfied with in your writing? What areas do you feel need improvement?
- In what specific areas have you grown this semester?
- Discuss your target paper. Why did you choose it? What did you do to revise it to make it representative of your best work?[3]

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[3] E. Grady, *The Portfolio Approach to Assessment*, Fastback 341 (Bloomington, IN: Phi Delta Kappa Educational Foundation, 1992), pp. 24-25. (ED 356 273)

Structuring Portfolio Assessment

The word *structure* is very important in the use of portfolio assessment. No meaningful assessment of a potentially huge folder full of stuff can occur without it. The first step is to work collaboratively with the learners to answer some planning questions related to that structure. For example:

- ***Will materials from every area of instruction be saved or from just a few selected areas (e.g., written materials only)?*** This can be a crucial question, particularly if you or the learners are new to portfolio assessment. Those who have used the approach strongly recommend starting small. If different types of tasks will be documented, maintaining separate working folders for each may be most practical.
- ***What types of materials will be collected?*** Will the portfolio contain every scrap of paper generated or only certain things? If the latter, what will be the nature of those "things"? Will materials from outside class be included (e.g., lists of books read, family budget prepared)?
- ***How often will materials be selected for the portfolio?*** The selection process can be painstaking and difficult, so selection activities should not occur too often. Furthermore, although reflection on one's work can be extremely valuable and exciting, ***if overused*** it can become tedious; documenting the reflection process in writing can easily become a routine chore rather than a stimulating learning experience.
- ***What criteria will be used for moving the material from the working folders to the portfolios?*** For example, should the portfolio ultimately contain a representative sampling of materials from various points in the learner's progress (what is "best" at different times) or the overall best materials? The criteria chosen should, of course, reflect program objectives.

- ***What process will be used for moving the material from the working folders to the portfolios?*** For example, will the learner make the decision alone, or will peers or the instructor or even outside "judges" participate in the decision-making process? (But remember, if this is truly to be the learner's portfolio, the ***final*** decision should be left to the learner.) Will the selection be justified in narrative form by the learner, or will checklists be devised for learners to use in the selection process; for example, a checklist of criteria defining what "best" means?[4]

Guiding Students in the Decision-Making Process

Once such questions have been answered and a practical structure planned, implementing the approach should become much easier. To help provide the kind of initial guidance learners may need in ***coping*** with making decisions in the face of a folder loaded with material, one teacher has suggested the following procedure:

- Ask the class, "If you were going to put all your work together in a book, how would you organize it?"
- Guide them in brainstorming to identify the many organizational schemes possible (e.g., chronological, alphabetical, subject area, things loved and things hated, successful things and unsuccessful things).
- Then have students actually go through their material and organize it in some way. A great deal of dialogue will occur as they see observable progress—as they encounter things they struggled with once but now have mastered.
- Have them describe, in writing, the organization they chose.
- Once everything is organized, the assessment and selection process will generally seem less overwhelming.[5]

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[4] Fingeret, op. cit., p. 4.

[5] Adapted from material by Melody Schneider cited in Fingeret, op. cit., p. 34.

Advantages

Like performance assessment, portfolio assessment is uniquely suited to the nature of integrated vocational-academic programs. It is learner-centered, focusing on the learner's own work and perceptions about it. All phases in the process—planning, implementation, and assessment—involve collaboration between the learners and the instructor and among the learners themselves. The materials used may involve the tasks the learner will need to perform in the workplace—authentic materials requiring the integrated use of basic skills. And often, development of the materials involves reflection and critical thinking. Perhaps the following best summarizes the value of this assessment approach—

> Teachers struggle with the relationship between their knowledge and judgments and those of their students during the process of assessing portfolios. There are questions about who sets the standards and who assesses the extent to which standards have been met.
>
> It should be remembered that this is not a standardized assessment process. You are not judging the extent to which students have met some predetermined standard set by outside experts in order to compare the work of your students with others' work. You and your students negotiate the standards in relation to the instructional goals and the curriculum, and you have to negotiate progress together as well.
>
> It is important to use your knowledge to help students learn to see their own progress and to give students the benefit of your experience and expertise. At the same time, it is important to learn about progress through the students' eyes, so that there is a richer overall understanding of learning and teaching in the end.[6]

It is important to learn about progress through the students' eyes, so that there is a richer overall understanding of learning and teaching in the end.

One Example

As one of its projects, a teaching team that participated in the Ideabook pilot test had senior auto collision students produce portfolios to document a project. Not only did this require students to apply skills from their various classes, it also provided a showcase of their work, which they could bring with them to job interviews.

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[6] Fingeret, op. cit., p. 37.

Ohio Hi-Point Career Center Teaching Team

Bruce Johnson, Auto Collision

Christine Galvin, Applied Communications

Jim Oliver, Applied Mathematics

- The auto collision teacher introduced the project to students and explained what was to be included in the portfolio: photos documenting their work (both process and product); step-by-step instructions for how to carry out the work; and a cost sheet for the job.
- Students then selected something they were working on for their project (painting a flame on a fender, preparing a car to be painted, working on the floor pans in a Mustang, etc.).
- Students began to work on their projects, documenting their work in photos.
- The auto collision teacher and applied communications teacher met to discuss the projects selected.
- The applied communications teacher provided instruction in how to write clear, complete instructions. Students then began to draft their instruction sheets in class, with teacher guidance. The completed instruction sheets were reviewed by both the applied communications teacher (for spelling, grammar, clarity, etc.) and the auto collision teacher (for technical accuracy). The students then keyed their final drafts.
- Although time constraints did not allow the full involvement of the applied mathematics teacher, he was able to advise the other teachers concerning the completion of the cost sheets.

The team plans to modify the process for future use. They feel it would have been a better project had it started at the beginning of the year, allowing the students more time and more choice. Better awareness of the available technology within the school (e.g., ability to digitize pictures onto the instruction sheets) also would have helped students produce more professional-looking products.

Nonetheless, the results were fairly successful, and students who put a lot of effort into their portfolios were very satisfied with the results.

Use Authentic Assessment Tools: Performance Assessments

Performance assessments should have the following three defining characteristics:

- Assessment tools derive from and focus on the ***competencies*** to be achieved. In applied academics classes, this would be the academic tasks described in the performance or enabling objectives.
- Assessment tools require actual ***performance*** of the task in a functional context (although factual knowledge may be tested separately, using paper-and-pencil methods, as a prerequisite to actual performance). Ideally, performance requires the integrated use of a number of related basic skills, as well as critical-thinking skills (e.g., problem solving and decision making).
- Performance is measured against established process/ product ***criteria***.

This information on authentic assessment tools was adapted from Sandra G. Pritz, Lois G. Harrington, et al., Assess Learner Performance. (Columbus, OH: Center on Education and Training for Employment, 1997), pp. 17, 20-23.

Devising the Problem Situation

The problem situation starts with an academic or vocational task selected for the program, preferably one related to the occupational context. For example:

Prepare a written report describing an equipment malfunction.

For the students to perform this task, however, they need more information. What equipment? What kind of malfunction? When did it occur? How often? In short, they need a description of the job-related problem situation: a *scenario*. Use of scenarios is also an extremely effective way of ensuring that assessment requires students to apply their full ***repertoire*** of basic skills in a functional context.

But, you say, I'm an academic teacher; what do I know about the job situation? Scenarios can come from a variety of sources:

- If you are familiar with the job situation, you can devise them yourself.
- You can draw on the information base provided in the OCAP to identify and devise problem scenarios.

- If you have a good relationship with students' occupational instructors, they can be tapped for the specific information you need to develop such scenarios.
- Students can develop scenarios—working alone, in small groups, or together with you as a total-class activity.

By involving the student, you can accomplish several very important purposes. Instruction becomes more student-centered, participatory, and collaborative. The problems described are those that actually constitute (or are perceived as) real problems for the students. In order to express those problem situations, the students must communicate: write or speak and listen. They may need to refer to written materials—to read—to provide all the facts of the scenario, and they will certainly need to read it once it's written.

Scenarios may also be called *case studies* or *case situations*. As defined by the Center on Education and Training for Employment for use in the development of competency-based learning guides—

- A ***case study*** describes a complete situation, including its solution. The student's job is to critique the process used and results obtained. What did the individual(s) described in the case study do right? What was done incorrectly? How could the process/results be improved?
- A ***case situation*** is open-ended. The problem situation is described, and it is up to the student to devise one or more appropriate solutions.

The situation should be as close as possible to the actual situation a worker might face on the job. The same materials and conditions should be provided.

As an example, consider how the task cited earlier—reporting an equipment malfunction—could be set up as a problem situation:

- Ask the students—as a whole class—to identify a problem involving an equipment malfunction they typically encounter in the vocational lab.
- Depending on the competency level of the students, either elicit the information required for the report, or make students responsible for specifying all the information they need.
- Guide the class in describing the situation orally, with students taking notes. If desired, summarize the descriptive information on a chalkboard or flip chart for future reference.
- Then have students individually develop equipment malfunction reports. If workers on the job would need to refer to equipment manuals or specifications or policy/procedure manuals in reporting the malfunction, then students should do so in the assessment situation as well.

Establishing the Performance Standards

One of the reasons objective test items (true/false, multiple-choice, etc.) have been so very popular is that they are, when well developed, ***objective*** rather than subjective. Grading an essay is harder because subjective judgment is involved. The trick is to ensure that professional judgment is tempered by established criteria defining the expected process and product standards. In applied academics and vocational programs, standards should come, at least in part, from the standards expected on the job. Criterion-referenced checklists can be used to evaluate performance objectively.

Criteria. Checklists can be developed to measure process, product, time factors, attitudes, or a ***combination*** of those elements.

- A ***product*** is something tangible, like a written report or a calculated budget. Sometimes measuring the product alone can tell you everything you need to know; the student could not have produced an acceptable product unless he or she followed the correct process.

- The ***process*** followed in performing the task should be evaluated if you want to track the steps the student performed. You may want to know, for example, whether all the words are spelled correctly in the student's written report because the student knew how to spell them—or did he or she use a dictionary, or did the computer's spell-checker do the job? Assessing process can also serve to ensure that the student doesn't short-circuit any critical steps in arriving at an acceptable product. Process will also be the focus in tasks without a tangible final product.
- Sometimes important ***time*** factors must be measured. If a worker notices an unsafe condition, for example, it may be crucial that he or she be able to communicate the facts of that situation immediately to coworkers and supervisory personnel.
- Often, ***attitudes*** are crucial on the job. The report must not only be written, it must be submitted on time and prepared with a concern for neatness and readability. Information must be communicated orally to coworkers and supervisors not just accurately but also professionally. To measure attitudes, you need to determine what ***behaviors*** would indicate their presence. For example, if the worker is "courteous" in dealing with customers, what does he/she ***do*** to demonstrate that courtesy (e.g., says please and thank you, acknowledges the customer's point of view as valid, volunteers to go the extra mile, maintains a pleasant facial expression)?

Rating scales. When you list the criteria together with a rating scale, you have a checklist. Various rating scales may be used; for example:

- yes / no
- not acceptable / acceptable / outstanding
- poor / fair / good / excellent

Bear in mind that students may use checklists for self-assessment and, because they're students, may not be able to make fine distinctions concerning level of performance. Therefore, it's better not to devise a 7-point rating scale. Consider, too, that the simple yes/no rating scale has in its favor no emotionally freighted terms like "poor" and "not acceptable."

Checklist qualities. Each checklist should have the following important qualities:

- The checklist should be ***short*** enough to make it practical to use. Perhaps 5 to 10 items are sufficient for a simple skill, 10 to 20 items (at the most) for complex skills.
- The criteria included must be ***critical*** to successful performance of the skill. Minor or trivial criteria just make the assessment job more difficult and time-consuming.
- Each criterion should have some ***qualitative*** base. It is not enough to record that the student did something (e.g., *used capital letters*); he or she may have done it poorly or very well, and this needs to be shown (*capitalized the first word in each sentence and all proper nouns*).
- The items must be ***simple*** and ***unambiguous***—quickly read and understood by the students and the busy instructor.
- Items should be stated in ***parallel*** terms (e.g., all in the past tense).

To return once more to our example, the following process/product criteria might be appropriate for the task, *Prepare a written report describing an equipment malfunction:*

In preparing the written report, did you—

1. identify the equipment by serial number?
2. indicate the date and time of day (24-hour clock) when the malfunction occurred?
3. describe the exact nature of the malfunction (e.g., sounds made, visual cues, problems, effect on product)?
4. indicate, step by step, the actions you took in response to the malfunction?
5. identify any potential safety hazards involved?
6. suggest any possible causes for the malfunction based on observation or past experience?

Was the completed report—

7. brief and to the point?
8. clearly and simply stated?
9. neat and organized in a way that would be easy to read?
10. directed to the appropriate person or office for action?

Administering the Performance Test

The test should not be something you ***do to*** students. Students can be actively involved through self-assessment. (Ability to self-assess is a useful quality on the job.) In competency-based programs, for example, the learning guides are frequently designed so that students practice the given competency and assess their performance against established (explicit, not secret) criteria until they feel competent. It is then up to them to contact the instructor for "final" assessment—to say, "I'm ready."

Even on final performance, students can be involved in the rating process. Differences in student and instructor ratings provide a good starting place in the discussion that should follow assessment. By comparing and discussing rating differences, you can help the student become a more accurate self-assessor in the future.

And if performance is not successful, the student does ***not*** just get a grade and move on. Part of the follow-up discussion in that case would be to jointly devise additional learning activities to help the student gain the required competence. The student would then pursue those activities, practice, self-assess, and request instructor assessment once again. The student would continue to "recycle" until competence is reached. Clearly, it is important to present this as a natural ***learning process*** and not a ***test-fail-retest sequence***.

Student progress through the program, therefore, is not determined by grades earned on units that have been covered and left behind. Rather, it is measured by the ***number of objectives achieved***—the number of academic or vocational skills demonstrated successfully—as measured by the established or prescribed criteria.

Revisiting Skills

Critics of the competency/performance-based approach like to point out that just because a student performs well once, it doesn't mean they will be able to perform equally successfully 3 weeks from now. (These critics do not seem to notice that the same complaint could be justifiably leveled at traditional educational approaches: cram for the test, take the test, forget the material.) Nevertheless, the concern is a valid one. As students' skills build, you should provide test situations that require them to use (and assess) already-acquired skills as well as new ones—preferably in an integrated way. This not only ensures that the skills have really been "acquired," it also serves to reinforce those skills.

As students' skills build, you should provide test situations that require them to use (and assess) already-acquired skills as well as new ones--preferably in an integrated way.

Use Rubrics

It is crucial that learning goals are well articulated and performance standards are set before students engage in the tasks that will be assessed. Students find it difficult to perform at high levels when the criteria are unknown. One of the best tools for establishing and communicating clear standards on products and performances is the use of rubrics. A rubric is set of scoring guidelines—the standards for assigning scores to student work.

Whereas a checklist gives a list of a items to be rated (e.g., The student incorporated verbal examples in the presentation) and then provides a simple rating scale (yes/no, none/fair/good/ excellent) that applies to ***all*** items, a rubric provides specific descriptors for rating ***each*** item.

For example, to rate a student's vocal expression in making an oral presentation (one item) on a 1-5 scale, descriptors could be provided for levels 1, 3, and 5 as follows:

5 = Uses voice expressively; varies tone to add emphasis
3 = Controls vocal expression; uses some expressiveness and appropriate tone
1 = Voice is unexpressive or monotone

This information on rubrics was adapted from Dee Allenspach, Sandra Laurenson, Robin White, and C. Michael Loyd, Alternative Assessment: A Family and Consumer Sciences Teacher's Tool Kit (Columbus, OH: Vocational Instructional Materials Laboratory, 1996), p. 103.

A rubric is a set of scoring guidelines, with specific descriptors provided for rating each item.

Advantages

A rubric provides teachers, as well students who are self-assessing, with more guidance in determining ratings—it helps make the assessment more objective. It also provides students with more specific information to use in improving their performance. In short, use of rubrics has the following advantages:

- Rubrics promote learning by offering ***clear, up-front performance targets*** to students, which allows them to see what mastery (and various degrees of mastery) of the task looks like. Students will know the basis for judging what constitutes exemplary/proficient, adequate/ satisfactory/acceptable, or novice/beginner/amateur work before they begin.

- Presented to students along with the performance/assessment task, rubrics provide students with ***"road signs"***—information about where they are in relation to where they need to be.
- Rubrics increase ***consistency*** in the rating of performances, products, skills, and understandings.
- Students are able to assess their own work based on ***specific standards/criteria*** and to "work up" to those standards.

Application of Rubrics

A recent SREB publication,[7] describes the use of rubrics by English teachers at Delcastle Technical High School in Wilmington, Delaware. The teachers use a locally developed rubric to evaluate students' writing assignments. Each assignment is graded on a point system, with one to four points awarded for each category. An average point value of 3.5–4.0 means that a student's assignment meets standards; 2.5–3.4 means that it approaches standards; and 2.4 and below means that it fails to meet standards. Students and teachers refer to the analytic scale shown on the following pages in deciding what point value to assign.

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[7] Bottoms, Gene, and Sharpe, Deede. *Teaching for Understanding through Integration of Academic and Technical Education*. Atlanta, GA: Southern Regional Education Board, 1996, pp. 25-27.

Writing Rubric: Analytic Scale

Delcastle Technical
High School;
Wilmington, Delaware

Topic

4 The assigned topic is carefully developed and supported by many relevant details.

3 The writer provides some insight or depth of understanding to the assigned topic. He/she is mainly on topic, but more development of details is needed.

2 The development of the assigned topic is generalized and lifeless. For the most part, only generalities are provided. The writer may stray from the topic.

1 The writer communicates no real understanding of the assigned topic and appears to have given little thought to selecting details that would enhance development.

Organization

4 The response is organized and unified, with smooth transitions and a clear, logical progression of ideas. If the composition is multi-paragraph, it has an introduction, only one topic per body paragraph, and a closing.

3 The order of ideas is generally clear to the reader because the writer has tried to order his/her ideas. Some transitions may be used, but they don't always support the orderly flow of ideas. In a multi-paragraph assignment, the paper may lack an effective introduction or closing. It may also treat more than one topic per paragraph.

2 Although there may be some attempt to present ideas in an orderly way, the general impression is that the paper is confused and disorganized.

1 The paper has no discernible order of ideas.

Style

4 The writer demonstrates a quality of imagination and individuality that results in a distinctive way of expressing him- or herself. Where suitable, the writer states what he/she really thinks and feels.

3 The writer may include some personal details and comments where suitable but also uses generalizations or value language at times. While the paper may be correct, it lacks a consistent expression of style.

2 The writer rarely uses personal details or comments. The style seems bland, guarded, flat, and not very interesting.

1 The writer demonstrates no recognizable individualistic style.

Word Choice

4 Words are specific and used accurately in a thoughtful, imaginative, and vivid way. Clichés and "a lot" are avoided. Similes, metaphors, and other figurative language may be used.

3 Some words are specific, thoughtful, imaginative, and vivid.

2 Common, stale words are used in the same old way. The repetition of words and phrases distracts the reader.

1 Word choice is limited and immature. Sometimes the word choice is inappropriate.

Sentences

4 The sentences are varied in length and structure, showing a control of sentence structure. The paper reads smoothly from sentence to sentence. Run-on sentences or sentence fragments are avoided. Correct punctuation makes sentences clear and easy to understand.

3 The writer shows some control of sentence structure and only occasionally writes a sentence that is awkward or puzzling. Most sentences are punctuated correctly.

2 The writer has definite problems with sentence structure. Some sentences are short and simple in structure or childlike and repetitious in their patterns. Sentence formation errors may be present.

1 There is almost no evidence that the writer has a command of English sentence structure.

Conventions

4 There are no obvious errors in spelling, punctuation, capitalization, and usage (verbs, pronouns, homonyms, etc.). The writer shows that he/she is familiar with the standards of edited written English.

3 A few errors in spelling, punctuation, capitalization, and usage appear in the paper, suggesting that the writer has not been consistent in using standard forms. Errors do not substantially detract from the overall effectiveness of the paper.

2 Errors in spelling, punctuation, capitalization, and usage are so numerous that they are distracting to the reader.

1 Errors in standard written English are serious and frequent enough to interfere with meaning.

Use Periodicals

Occupation-specific or general career magazines and local, regional, or national newspapers can provide a rich source of classroom activities.

Sources of Materials

The following are just a few of the types of sources you might consider for use in your classes:

- Do your students belong to a vocational student organization such as the Vocational Industrial Clubs of America (VICA)? If so, they probably receive copies of the organization's journals.

  Vocational Industrial Clubs of America (VICA)
  Phone: 703-777-8810; Fax: 703-777-8999
  E-mail: <DialogVICA@aol.com>
  Website: <http://www.vica.org>

- Do (or could) your students subscribe to a career-focused magazine such as *American Careers*? Career-related articles and statistics provide a natural jumping-off place for a wide range of classroom activities. Furthermore, magazines developed specifically for classroom use generally come with a teacher's guide detailing creative ways of using the articles in each issue.

  American Careers, Career Communications, Inc.
  Phone: 800-669-7795; Fax: 913-362-4864
  E-mail: <ccinfo@carcom.com>
  Website: <http://www.carcom.com>

Occupation-specific or general magazines and newspaper can provide a rich source of classroom activities. The types of activities they support are limitless.

- Many newspapers provide classroom sets of their papers for a limited time period, either free of charge or at a discounted rate. Some major papers (e.g., those in large cities, *USA TODAY*) also provide teaching guides to support use of the materials.

  USA TODAY
  Phone: 800-782-2230
  Website: <http://www.usatoday.com>

These are high-interest materials containing relevant, real-world information, and the types of activities they support are limitless.

Classroom Applications

An ***applied communications*** teacher could use activities such as the following:

- Have students read an article or editorial on a controversial subject and then participate in a class or panel discussion or debate.
- Teach (or review) how newspapers are typically structured and laid out, and then ask students to locate specific articles or types of information in the paper. For some classes, making this a competition will add motivation.
- Teach how newspaper articles are typically structured (e.g., using the inverted pyramid structure; answering the 5 W's in the lead paragraph). Then have students complete activities related to that structure, such as answering the 5 W questions for given articles.
- Have students identify a job they'd like or a car they'd like to own and then find out facts and figures related to that choice using the classified section of the newspaper. Have them pick the three jobs/cars advertised that seem to be most desirable and explain the criteria used in making their decision.
- Ask each student to skim the newspaper headlines (or journal article titles) and pick an article of interest to read and report on orally to the class. Have students take notes and briefly outline their presentations before making them. To minimize duplication, divide the class into smaller groups, and give each group one section of the newspaper to pick from.
- Students could each be assigned an article to skim and asked to circle each unfamiliar word. They could then use prefixes, suffixes, roots, context, etc., to try to define the word. Through class discussion, the words could be shared and tentative definitions could be improved.

An ***applied mathematics*** teacher can make very effective use of the charts and tables and statistics found in most newspapers and many journals, such as sports statistics, stock market data, and top 10 movies.

- Have students read and interpret the data provided
- Give students scenarios or problems and ask them to use the data in responding to the scenario or solving the problem.
- Assign long-term projects as well. For example, have students build a database of statistics over time for a specific sports team or select a stock to "buy" and then follow and chart its progress.

An ***applied science*** teacher can find ideas for activities in articles or business sections featuring new technology, particularly that related to students' occupational area(s). The weather page is another natural resource. One activity from a *USA TODAY* teaching plan relates to an article entitled, "Life May Have Once Existed on Mars." Students are asked (1) to imagine that people living on Mars millions of years ago are looking through a high-powered telescope pointed at Earth and (2) to describe what those people might see. (This could easily be a joint English-science assignment.)

Simulate the Workplace

Some students come late to class. They skip school. They turn in homework late or not at all. Assignments that are turned in are carelessly done, sloppy, and incomplete. They treat the teacher—and each other—with little respect. So what? they say; it's only school.

Many teachers have found that when they turn the classroom into a workplace and treat their students as workers, there is great improvement in both attitude and performance.

In Instruction

For Thomas Grandy, an applied communications teacher at Ashland-County West Holmes Career Center whose students were in Business programs, this meant turning his classroom into a simulated business: ComQuest: A Communications Catalyst. Students were employees of this company; Grandy was the CEO.

Many teachers have found that when they turn the classroom into a workplace and treat their students as workers, there is a great improvement in both attitude and performance.

Classes were run like business meetings, with activities centered around fictional companies or lab experiences (and a strong focus on the SCANS competencies). For example, there were discussions on work relationships and professional issues. To reflect the real world of work in which time is limited, students were required to keep the discussion focused; at the end of the activity, they had to write a synopsis.

Students were also asked to do magazine research of career-specific topics. Other activities included business correspondence, telephone etiquette activities and role play, customer relations study and role play, and teamwork activities (e.g., "human knot," in which a circle of students hold hands in a tangled way and must communicate to get untangled).

When businesses sell products, a technical writer must develop instructions for their use. Thus, Grandy's activities also involved writing effective instructions. In one activity, he had students bring in a collection of tools from their lab and work in teams of four to write a set of instructions for each tool. In another activity, he provided a strange collection of kitchen tools and antique tools. Groups of four then had to identify the real—or imagined—purpose of a selected tool and write a set of instructions for its safe use.

On the job, you're paid by the products developed, by the time on task. Thus, Grandy had students keep logs of their activities in lab for one week. The logs were then used as a basis for lessons on effective time management.

As more technology has become available, the activities in his classes have become more sophisticated. Students now participate in an international business study, conducted online with Russian students. They use real customers in some of the projects, which provides opportunities for real-world experience in effective communication. Grandy finds that the feedback students receive from customers concerning their performance has a great deal more credibility (and is more likely to result in improvement) than that provided by the teacher.

ComQuest's Website can be found at <http://www.tccsa.ohio.gov/dp/awhj/home1.htm>. The CEO can be reached by e-mail at <AWHJ_GRANDY@tccsa.ohio.gov>.

In Assessment

Another truth about the real world of work is that when a worker hands in unacceptable work, he or she doesn't get a grade and another assignment. In most cases, the work is handed back to be made right. Thus, you can also simulate the workplace in your assessment practices.

According to Ted Panitz <tpanitz@mecn.mass.edu>

> I use a mastery approach to testing where I check mathematics exams for correct answers and return the papers for corrections during the exam. I do not give partial credit at this point; I simply circle the problems that are not correct. The passing grade is 80% after the corrections are completed and if students obtain the 80% I then keep returning the tests until the student has 100% correct answers. The emphasis is on understanding the problem, not the grade, and all students become capable of obtaining a perfect test.
>
> The effect of this approach is to empower the students, create a positive assessment atmosphere, and encourage students to take more responsibility for their learning and success. This approach encourages students to keep trying problem solutions until they figure out how to solve a problem. It helps them get past the problem of making silly mistakes that imply they do not understand a concept because they did not get the exact right answer. It demands that they keep thinking about a solution until they resolve in their minds how to complete it.[8]

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[8] Panitz, Ted. "How Do You Communicate High Expectations to Your Students in Order to Encourage Their Success?" *School-To-Work News* (July/August 1996): 5.

Ohio Hi-Point Career Center Teaching Team

Bruce Johnson, Auto Collision

Christine Galvin, Applied Communications

Jim Oliver, Applied Mathematics

Through Media

Another way to bring the world of work into the classroom is to videotape it. As part of the Ideabook pilot test, the teaching team from Ohio Hi-Point Career Center set out to produce a simple video presentation for auto body students on why academic skills are so critical in the world of work. The video would show owners and managers of automotive businesses explaining the mathematics and communications skills required on the job—the skills they look for when hiring (or promoting) workers.

But this was a team project that just grew and grew:

- They consulted the school's media specialist and decided to produce an interactive CD instead. Using CD technology would provide for user interaction and more versatility.
- When the team members learned how much data could be stored on one disc and how easy it would be to sort and access the data, they decided to cover ***all*** the auto trades in the presentation. They hope to cover not only the repair side of the business, but also the supply side (parts stores and distributors) and the manufacturing side (the Ohio Honda plant is in their district).
- Instead of just interviews (talking heads), plans now call for reinforcing interview comments by showing employees actually using those academic skills on the job whenever possible. Alternatively, footage can be taken of vocational students applying those skills in the auto labs.
- Initially, the team members planned to do most of the taping themselves, but on further thought, they decided to use students to do the interviews and produce the CD presentation. The media specialist is helping students learn how to transfer material to CD. Students in graphic arts classes are developing graphics for the CD. Students in applied communications classes are working on interview techniques.

Because students seem to pay far more attention to the owners and bosses of the shops in which they hope to work, the team hopes that using this CD in future classes will help provide some much-needed motivation for students to master academics.

Incorporate Projects

Projects can be a wonderful kind of hands-on activity when they involve creativity and teamwork and problem solving. They also allow many opportunities to build communication skills. Projects tend to be multidisciplinary, even when conducted within a single course. For example, the deck project described later in this section involves knowledge of the occupation, oral presentation skill, mathematical calculations, and a written product. However, projects can also be the focus of instruction in two or more courses. The following is a sampling of approaches and projects you might want to incorporate into your instruction:

Projects can involve creativity, teamwork, problem solving, and opportunities to build communication skills.

⚠ One caution should be mentioned here: Keep it fresh! When a perfectly good project is used year after year, it can lose its effectiveness. Assume, for example, that an applied communications teacher has a class track down all the safety hazards in the school facility and develop a brochure on school safety to be shared schoolwide. Great activity—authentic, with an actual, useful application. But if that teacher tries the same project with next year's class, it's just busywork. The class members know the task has already been done; they have copies of last year's brochure in their possession. It's time for a new project.

Rube Goldberg Approach

With this approach, students invent an extremely complicated—and usually silly—device that uses a series of mechanical actions to complete a very simple task such as setting off a mousetrap. It works like this:

- You (or students) bring in a variety of household items (often trash, like cardboard paper-towel tubes).
- Small groups of students are asked to pick a problem (e.g., bursting a balloon) and use the available items to design, build, and demonstrate a device that will solve it. You may specify the criteria to be met (e.g., the device must have a minimum of five mechanical actions and reactions).

- Once the projects are completed, students present their devices. They can be evaluated not only on the quality of their projects but also on the effectiveness of their presentation skills. By videotaping these presentations, you can build a library of examples that can be enjoyed by students in the future.

LEGO® Project

Thomas Grandy, applied communications teacher at Ashland-County West Holmes Career Center, has students build something using LEGO® blocks and write up specific instructions for how the structure was built. The structure is then taken apart, and the LEGO® blocks and the instructions are placed in a plastic bag. Students trade plastic bags, and each student tries to recreate the original structure using the instructions. If the instructions are not adequate, they are returned to the author for revision.

Chaucer Projects

Darla Boram, applied communications teacher at Upper Valley JVS, approaches the study of Chaucer from a project point of view. She starts with a unit on mythology to help unlock some of the allusions in the work. She interweaves information on the Middle Ages, talking about things with high student appeal, like chivalry, and bringing in lots of high-interest books on castles and such. Since the language of the original *Canterbury Tales* is, in essence, a foreign language, she uses a translation that is easy for students to understand, while maintaining the rhythmic quality of the original. Classroom instruction focuses on just the Prologue and a few of the tales. And the culminating project? Students develop a book of their own *American Tales*—written in iambic pentameter. Secretarial and data processing students key the book; graphic arts students bind the books. A book cover design contest can also be part of the project.

For students in construction trades, a *Canterbury Tales* unit could easily also involve a castle-building project, perhaps with the involvement of both the applied communications and construction teachers. Students could design or actually build scale models of medieval castles or even construct an entire medieval town. Other potential academic applications:

- Students could develop scale drawings for the models and calculate the materials needed in mathematics class.
- In science class, they could test the strength of various materials before selecting those they will use in building the models. They could study the relationship between shape and strength.
- Oral presentations could be made about the buildings and their residents—focusing, for example, on the type of housing each level of society (nobles, clergy, merchants, peasants) lived in, or the functions of the various elements of the medieval structure (e.g., battlements and crenellations).

Deck Proposal Project

In their presentation at the 1996 All-Ohio Conference, Mary Helen Steinauer and Kathy Freeman from Great Oaks Institute of Technology and Career Development shared a description of the Carpentry Presentation Project. The class is divided into three "companies," and each company is given a $5,000 budget to complete a deck to be added to a house the company is currently building. Each company devises a project proposal and then tries to persuade a panel to "purchase" it.

Each proposal must include the following:

- Illustration of the proposed deck
- Oral presentation concerning the proposed project
- Visual aid(s) to help persuade the panel to choose the company's proposal
- Detailed estimate of the proposal
- Written description of the proposed project (using technical writing)
- Estimated date of completion
- List of anticipated questions
- Evaluation of each group member

The panel consists of several adults who judge each project before deciding which company is awarded the "contract." The winning company receives 20 extra-credit points.

"Best Place to Live" Project

A long-term project at Canton High School and Canton Career Center in Mississippi was described as follows:

> Students searched for the best U.S. city and region in which to live. Teachers from the academic areas of English, algebra, physics, and social studies worked with vocational teachers to plan the project. For each city selected, the students obtained information on size and population, architecture, racial makeup, living conditions, and regional technology.
>
> Students were evaluated on data collection and analysis; use of communication skills in designing a questionnaire and writing cover letters to obtain information; design and organization of a scrapbook of data and articles on the cities; an oral presentation on research findings; design and construction of a plywood map showing cities and regions; and decision-making skills.[9]

Career Magazine Project

Development of a career magazine can also be an effective multi-course project. Students can work in applied communications classes to research jobs within their occupational area. They can work with the applied science teacher to identify and learn about new technology related to the field—another source of articles for their magazine. In applied mathematics classes, they can summarize data related to the field (e.g., percent of growth in each job over the last 10 years) and develop charts and graphs to present that data.

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[9] "Progress Reports: HSTW Sites Share Integration Activities." *Integrated Learning* (January 1996): 12.

Grill Project

Welding students at EHOVE Career Center typically complete a project involving the construction of a personal hibachi grill. As part of the Ideabook pilot test, however, the EHOVE teaching team expanded the project to the applied mathematics and communications classes as well.

- Welding Class: Students were given plans for the construction of the grill. Each student was then responsible for the economical layout and cutting of each of the parts necessary for the grill's construction. Each student also had to determine the total number of welding rods needed to complete the project. Once the project was completed, each grill was evaluated based on criteria related to its dimensions; the quality of the fit and finish; and the depth, thickness, and porosity of the welds.
- Applied Math Class: Instruction focused on helping students (1) calculate the total cost of the grill; (2) determine the selling price given a certain percentage of markup; and then (3) determine the costs of going into mass production with a workforce of eight welders. Student activities involved (1) researching the current cost of the steel, welding rods, and gases used in the project; (2) contacting three fabricating shops to determine the average hourly wage for a welder; (3) calculating the total amount of steel and total number of welding rods needed to build the grill according to the plans; and (4) keeping a record of the number of hours worked and the amount of each gas used in completing the job.

EHOVE Career Center Teaching Team

Chuck Livermore, Welding

Brett Dickey, Applied Math/Science

Jerry Mahl, Applied Science

- Applied Communications Class: Instruction focused on advertising techniques. Then, working in teams of four, students were responsible for developing an advertising campaign—a television, radio, and newspaper advertisement—to promote their product: the hibachi grills. The campaign had to be based on ***one*** advertising technique (humor, celebrity endorsement, popularity, improved appearance or health, bandwagon, or status) and according to the following specifications:
  - ✓ TV ad specifications: 1-minute ad, including a script and story board.
  - ✓ Radio ad specifications: 1-minute ad, including a script.
  - ✓ Newspaper ad specifications: must include a picture of the product, a name for the company, and a slogan for the product.

  Radio and TV ads were acted out in class.

When the team implemented their plans, student response was ultimately positive. However, team members discovered that their plans were overly ambitious. Designing an entire ad campaign took much longer than anticipated. Furthermore, instruction in mathematics class related to mass production was more detailed than students needed. Thus, in the future, students will be asked to design and write only a script for a TV ad. And more time will be spent helping students in mathematics class to understand unit cost and how to calculate the value of the time and materials that go into making a product.

Model building will also be added to the project in the future. Using masking tape and cardboard, each student will build a full-scale model of the grill in order to improve his/her measuring skills and ability to lay out materials economically.

Mathematics and communications lessons could also be further integrated. For example, instead of writing an advertisement, students could make presentations of their cost-analysis findings using charts and graphs. An entire mathematics unit on the use of charts and graphs could culminate in a presentation in communications class.

Trailer Project

The EHOVE team also has devised an integrated plan for a project in which welding students design and fabricate a product of their own choosing. Students have the following responsibilities:

- Draw a shop sketch, get it approved, and then draw a detailed blueprint.
- Use the blueprint to determine materials needed, get prices for the materials, and complete a cost breakdown sheet.
- Visit local manufacturers of the product and determine what special selling factors help sell that product. Observe salespersons as they try to sell the product to consumers.
- Prepare a sales presentation.
- Produce a brochure for the consumer that includes options designed to fit varying consumer needs.
- Role-play selling the product to a "customer."

When this project was implemented, students chose to produce a trailer. In science class, they studied stress factors and selection of the most economical shielded gases and best electrode for the job. In mathematics class, they focused on cost analyses and how to calculate square feet, square inches, running feet, work hours, and payroll. In communications class, they learned how to develop effective brochures and sales presentations. And in welding class, they actually designed, fabricated, and sold a 20-foot car trailer.

Use Demonstrations and Discovery

Science and mathematics lend themselves very nicely to the discovery—or inquiry—method. Instead of presenting a formula or scientific principle to students and then moving on to application, start with the application and let students try to deduce the formula or principle themselves.

Many books are filled with demonstrations and experiments that can be used in this way (some are listed in the final section of this document). The best demonstrations/experiments are those that present the principle in relation to the students' occupational area. But regardless of the content, it is critical that the activity move beyond simple fun to the discovery of the underlying principle. You may get students' attention when you perform what looks like (and may in fact be) a dangerous task, but their attention is worth little if learning does not occur. An ideal way to ensure that the principle has been learned is to follow up the first demonstration/experiment with a completely different one in which the same principle applies.

It is critical that the activity move beyond simple fun to the discovery of the underlying principle.

Demonstrating a Science Principle

To teach the characteristics of nonutonian fluids, Eric Roby, an applied science teacher at Eastland Career Center, uses a cornstarch and water mixture. The mixture increases in viscosity the faster you move it. If you slowly insert and remove your finger, the mixture acts like a liquid. If you jab it quickly, the mixture resists penetration like rubber. If you try to pull your finger out quickly, the mixture grabs the finger and hangs on.

Demonstrating Math Skills and Principles

An applied mathematics teacher at EHOVE Career Center has students in ***construction trades*** learn volume calculation by using the sidewalks outside the building. He starts with some background work in volume calculation and then takes them outside to tackle the sidewalks, some of which have curved edges. They work in groups to measure the sidewalks and work up an estimate of the concrete needed if the sidewalks had to be replaced. Students are told to assume a 4"-thick sidewalk and a cost of $50/cubic yard. He also has them sketch the sidewalk and label the dimensions. Their calculations must be accurate to the nearest 1/4 cubic yard.

For ***automotive*** students, this same teacher uses an activity that provides a capstone for lessons on gears, rates, and circumference. He has groups of students try to devise a way of calculating a car's speed (MPH) from the RPMs of the crankshaft (or vice versa, from MPH to RPMs), given the gear ratios of the transmission and differential, and the diameter of the tire. If the students can find the gear specifications on a manual transmission car that has a tachometer, then their calculated results can be verified.

This teacher has ***welding*** students design a container. Instead of giving the dimensions of a large container and having them calculate the capacity, he does the opposite. He tells them he needs a cylindrical-shaped container that holds 250 gallons of water and then has them work out the dimensions and draw a sketch of the container needed. They also need to work out a way to lay out the sheet metal to save on material costs—a way that is most economical.

Use Planning Tools That Support Integration

When you are building your unit and lesson plans, it is very easy to get caught up in the subject you love best—the one in which you are certified to teach—and to forget about integrating material from other classes into your plans. The planning checklist that follows can help you focus on ***integration*** in your plans by reminding you of all the categories to consider, all the intersections possible. Since instructional ***variety*** is one of the keys to lesson success, this form also reminds you to look at—and use—the many instructional/assessment strategies and resources available to you.

Integration Planning Checklist

Lesson Topic: ____

For each of the following five focus areas, check all responses that apply.

Skills/concepts from which of the following areas can be presented/reinforced in this lesson?

- ☐ Applied Communications
- ☐ Applied Mathematics
- ☐ Applied Science
- ☐ Technology Literacy
- ☐ Employability Skills
- ☐ Teamwork
- ☐ Professionalism
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

- ☐ Auto Collision
- ☐ Auto Tech
- ☐ Truck/Equipment Tech
- ☐ Precision Machining
- ☐ Welding
- ☐ Electrical Trades
- ☐ Electronics
- ☐ Building/Property Maintenance
- ☐ Carpentry
- ☐ Masonry
- ☐ Plumbing
- ☐ Heating, Air-Conditioning, and Refrigeration

Applicable Instructional Strategies/Activities:

- ☐ Demonstrations
- ☐ Lectures/Illustrated Talks
- ☐ Projects
- ☐ Portfolios
- ☐ Scenarios
- ☐ Case Studies
- ☐ Workplace Simulations
- ☐ Thinking Strategies (Metacognition)
- ☐ Problem Solving
- ☐ Decision Making
- ☐ Discussion
- ☐ Brainstorming/Buzz Groups
- ☐ Discovery Method
- ☐ Role-Playing
- ☐ Team Teaching

- ☐ Field Trips
- ☐ Guest Speakers
- ☐ Mentoring
- ☐ Teamwork
- ☐ Computer-Aided Instruction
- ☐ Interviews/Surveys
- ☐ Community-Based Activities
- ☐ Research/Independent Study
- ☐ Laboratory Activities
- ☐ Drill/Practice
- ☐ Games
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Applicable Instructional Resources:

☐ Vocational Texts
☐ Applied Academics Texts
☐ Authentic Materials
☐ Journals
☐ Newspapers
☐ Word Processing Software
☐ Communications Software
☐ Internet
☐ CD-ROM
☐ Videotapes
☐ Audiotapes
☐ Films
☐ Overhead Transparencies
☐ Handouts
☐ Models
☐ Real Objects
☐ ________________
☐ ________________
☐ ________________
☐ ________________
☐ ________________
☐ ________________
☐ ________________

Applicable Assessment Strategies:

☐ Objective Test Items (e.g., multiple-choice, true-false)
☐ Open-Ended Test Items (e.g., essay, short answer, oral)
☐ Performance Assessment
☐ Performance Checklists
☐ Rubrics
☐ Portfolio Assessment
☐ ________________________________
☐ ________________________________

Assessors To Be Used:

☐ Vocational/Tech Prep Teacher
☐ Applied Communications Teacher
☐ Applied Mathematics Teacher
☐ Applied Science Teacher
☐ Student (self-assessment)
☐ Peers
☐ Representatives from Business, Industry, and Labor
☐ ________________________________
☐ ________________________________

Devise Joint Plans with Other Teachers

Teaching teams that participated in job-site externship experiences and the Ideabook pilot test as part of Ohio's Work SITE Learning project spent time developing lesson plans tying the world of the classroom to the world of work. Some of these plans involved blending authentic experiences into the applied academics classes. Some involved joint activities between the vocational teacher and one or more academic teachers.

On the following pages, you will find a sample planning format, a blank form, and examples of the plans that were produced.

According to a report prepared by Brett Dickey for the teaching team from EHOVE Career Center—

> The greatest obstacle to the integrated lessons came from the students. They are very much indoctrinated into the system of having their subject matter divided into very distinct units of time. It took them some time to get used to the idea that they were to work on the same project in more than one of their classes. It was not unusual to hear them complaining, saying things like, "Why do we have to do that now? That's what we worked on in math today" or "That's for welding class, not communications class." However, once they adapted to the idea that their work in three classes was to center around a single project, the work improved, and complaints were heard less often. Some students even said that they wished more of what they were taught were presented in this format.
>
> One of the strengths of the integrated lessons was the constant reinforcement and feedback that students received. The teachers were able to communicate more effectively with the students since they were aware of what was going on in the other classes. This served to keep students on task since everything they did centered around one project.

Hint: To be able to share your plans with others, you need to provide sufficient detail so that it will make sense to someone else. If another teacher cannot replicate the lesson because you have failed to include full explanations or complete information, the plan is not helpful.

Sample Format

In the sample format shown below, italics indicate the directions for completing each section.

Occupational Area: *e.g., HVAC, Electronics, Health Tech*

Academic Area: *e.g., Applied Communications or Mathematics or Science*

Activity Topic / Skill Area: *e.g., Calculate volume of concrete needed for sidewalk*

Description of Workplace Context: *This should NOT be simply a repeat of the Activity Topic / Skill Area, nor should it be school-based. In other words, DON'T just say, "Students need to measure volume," or "It is very important to measure volume." Instead, explain WHY it is important.*

This section should answer the student's eternal question, Why is this important to me in real life? It should focus on what workers do, and it should explain in more detail how the topic/skill is actually used on the job (e.g., in what situations, under what conditions?). It should also explain why the skill is particularly important—if it is (e.g., what could happen if the worker doesn't possess this skill or doesn't perform it well?).

Description of Related Classroom Activity: *This section needs to provide a clear, detailed, step-by-step explanation of the activity. It should be written so that an applied academics teacher who knows little or nothing about the occupational area could actually present the activity.*

Materials / Equipment: *Just list the major ones.*

Estimated Time Required: *e.g., four 50–minute periods*

Extended Activity: *This section should provide creative, challenging ways in which the students can pursue the lesson topic in more depth or breadth.*

Authors: *List each teacher, subject area, and the school.*

Integrated Vocational-Academic Lesson Plan

Occupational Area:

Academic Area:

Activity Topic / Skill Area:

Description of Workplace Context:

Description of Related Classroom Activity:

Materials/Equipment:

Estimated Time Required:

Extended Activity:

Authors (name, teaching area, school):

Auto Technology

Occupational Area: Auto Technology

Academic Area: Science

Activity Topic / Skill Area: Density of Liquids (Measuring)

Description of Workplace Context: Auto technicians need to understand density as it pertains to liquids (specific gravity). Density is a scientific principle that allows liquids to be analyzed for change of electrolytes in a battery, or antifreeze to be analyzed for protection level.

Description of Related Classroom Activity: Several different fluids can be analyzed using a hydrometer. Bring several workplace fluids (e.g., oil, water, antifreeze, alcohol) into the classroom. Place them into beakers and have students measure the fluids using hydrometers and record the results. Compare one to the other. Is water less dense than oil? Which will float if mixed?

Materials / Equipment: Hydrometer, fluids (e.g., oil, water, antifreeze, alcohol)

Estimated Time Required: 50 minutes

Author: Mike Pottmeyer, Principles of Technology, Springfield-Clark County JVS

Auto Technology

Occupational Area: Auto Technology

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Measuring Electricity

Description of Workplace Context: Almost every system on today's vehicles has some connection with electricity. Thus, auto technicians need to understand basic electricity, formulas associated with electricity, and meter usage.

Description of Related Classroom Activity: In the classroom, students will work on scientific notation, Ohm's law, series circuits, and parallel circuits. They will also learn to use analog and digital meters. In the laboratory, students will measure the length of spark plug wires and the resistance of each wire and then determine whether each wire is usable. They will be given a worksheet to document their findings.

Authors: Paul Kruthaup, Auto Technology; Tim Perry, Applied Mathematics; Whitmer High School

Occupational Area: Auto Technology

Academic Area: Physics

Activity Topic / Skill Area: Electricity; Efficiency of Different Loads

Description of Workplace Context: The battery and alternator of a car must provide power for all electrical devices. Thus, auto technicians need to understand the efficiency of each device. Car owners, too, can benefit from a better understanding of how their cars work.

Description of Related Classroom Activity: Students in auto tech class will build electrical simulators that will have a variety of different loads, including heat, light, sound, rotary and linear motion. They will measure both voltage and amperage for each load. The boards will then be taken to the college prep students in a physics class, where measurements will again be taken and compared to the originals. These students will diagram the circuits and calculate and compare the type of energy conversions and efficiencies. Final data will be reviewed by the auto tech students.

Materials / Equipment: Electrical components and boards, batteries, meters (amps, volts, ohms)

Estimated Time Required:

Build and label boards: 3 hours (auto tech)

Collect data: 2 hours (auto tech)

Collect/compare data; diagram circuits: 3 class periods (physics)

Analyze data: 1 class period (physics)

Review data: 1/2 hour (auto tech)

Authors: Harry McPheron, Auto Technology, and Jack Albers, Tech-Prep Coordinator, Tri-Star Career Compact; Pam Grew, Physics, Minster High School

Occupational Area: Auto Technology

Academic Area: Chemistry

Activity Topic / Skill Area: Chemical Usage and Safety

Description of Workplace Context: In servicing vehicles, auto technicians need to use and dispose of chemicals safely. They need to understand the precautions associated with using them and how to dispose of them correctly.

Description of Related Classroom Activity: Students in auto tech class will formulate a list of chemicals used in their work, together with the chemical name and use whenever possible. Material safety data sheets (MSDSs) will then be introduced to college prep students in chemistry classes. Pairs of chemistry students will each research one of the identified chemicals and develop an MSDS specifically for that compound. They will then prepare posters for clusters of similar compounds. The posters and MSDSs will then be returned to the auto tech lab for review and feedback by auto tech students.

Materials / Equipment: Containers of various compounds (labels contain lists of chemicals), resources for research (Merck index, Internet, etc.)

Estimated Time Required:

Compilation of compound list: 1/2 hour (auto tech)

MSDS introduction: 1/4 hour (chemistry)

Student research: 1/2 hour in-class and 1/2 hour outside class (chemistry)

MSDS and poster development: 1.5 class periods (chemistry)

Analysis of results: 1/2 hour (auto tech)

Feedback to chemistry students: 1/2 hour (auto tech)

Authors: Harry McPheron, Auto Technology, and Jack Albers, Tech-Prep Coordinator, Tri-Star Career Compact; Pam Grew, Physics, Minster High School

Auto Technology

Occupational Area: Auto Technology

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Micrometer Usage

Description of Workplace Context: Micrometer usage is important in such areas as automotive engine machining, brakes, differentials, and transmissions.

Description of Related Classroom Activity: In the classroom, students will work on decimal usage and the parts and functions of the micrometer. They will also work in teams to measure small components such as pennies, bolts, and valves. In the laboratory, students will measure brake rotors at assigned job stations in the lab. They will be given a worksheet to document their findings.

Lesson Results: Micrometer operation had to be retaught because some students misunderstood decimal placement. The lab activity had to be restructured to reduce the congestion at each station.

Authors: Paul Kruthaup, Auto Technology; Tim Perry, Applied Mathematics; Whitmer High School

Auto Technology

Occupational Area: Auto Technology

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Ratios and Proportions

Description of Workplace Context: Ratios and proportions are important to areas such as pulley and drive systems, transmissions, differentials and transaxles, and tire size.

Description of Related Classroom Activity: In the classroom, students will work on calculations and formulas dealing directly with ratios and proportions. They will also work in groups on problems such as tire size ratios and speedometer gear ratios. In the laboratory, students will measure crankshaft diameters, power steering diameters, and alternator diameters. They will then find the revolutions per minute on these components with given crankshaft RPMs. Students will be given a worksheet to document their findings.

Lesson Results: The first attempt at using this lesson was fairly successful, although some review of fundamentals was necessary. Suggestion: Be sure to select vehicles in which the components to be measured are accessible.

Authors: Paul Kruthaup, Auto Technology; Tim Perry, Applied Mathematics; Whitmer High School

Occupational Area: Commercial Truck/Equipment Technology

Academic Area: Applied Science

Activity Topic / Skill Area: Relationship of Voltage, Amperage, and Ohms

Description of Workplace Context: Commercial truck/equipment technicians need to understand the relationship of voltage, amperage, and ohms in order to troubleshoot electrical problems and defects.

Description of Related Classroom Activity: Students will hook resistors in series or series/parallel with an electric motor (such as is used to circulate the air in the heater/air-conditioner of a truck) and measure voltage drop, amperage, and resistance. By recording their results on worksheets (provided by the teacher), students will be able to compare voltage drops, motor speed, current flow, and even magnetism within a circuit and predict the outcome if variables (voltage or resistance) are changed.

Students will also substitute lamps or lights in place of the motor and observe differences in brightness. Using a thermistor, they will experience the difference in bulb temperature as resistance or voltage is changed within the circuit.

Activity 1: Build the electrical module (project board)

Activity 2a: Use the project board to make the following predictions:

- What happens to total resistance when resistors are connected in series? in parallel?
- What happens to voltage drop across, and current through, resistors when they are used individually? in series? in parallel?
- What happens to voltage drop across the fan and fan speed when resistors are used individually? in series? in parallel?
- What happens to the strength of the electromagnet when resistors are used individually? in series? in parallel?
- What happens to the temperature of the light bulb when resistors are used individually? in series? in parallel?

Activity 2b: Use the project board to make the following measurements:

- Using a digital VOM meter, measure resistance, voltage, and current as needed from the predictions above.
- Using an RPM meter, measure fan speed.
- Using paper clips, measure the strength of the electromagnet.

Activity 2c: Record and organize the data using correct units to label measurements (volts, amps, ohms, rpm).

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Activity 2d: Summarize the findings to show relationships (e.g., use statements such as, "The greater the resistance the [faster / slower] the fan speed").

Activity 3: Draw a schematic of the project board using the correct symbols. Show current through only one resistor. In an inset (a small diagram off to the side), show the option of series and parallel resistors. Give two examples for the application of resistors controlling (1) motor speed, (2) temperature, and (3) magnets.

Materials / Equipment:

- Multimeter with 20-amp capacity (or voltmeter, ammeter, and ohmmeter)
- 6-8 jumper wires, with alligator clips
- Electrical module (description provided on following page)
- Power source (12V battery or AC to DC transformer)
- Photo tach or strobe light (for determining motor speed)
- Paper clips or steel washers (for measuring magnet strength)
- Teacher-developed worksheets and handouts (not included here)

Lesson Results: Construction of the electrical module by the students took longer than expected (5 days). They encountered some problems and solved them in a manner the science teacher would not have thought of (which was good). The most difficult part was working in a "semi-science lab" instead of a workshop. The drill went into the lab tables three times (once accidentally and twice on purpose). The hammering bothered the neighboring classes. But student enthusiasm for the project was really impressive. In particular, one student who had earned Fs for the first two quarters sprang to life on this project.

Extended Activity: Students will use the knowledge gained from the lesson to troubleshoot problems in simple light circuits or complex computer controls used in trucks and equipment.

Authors: Connie Wyatt, Applied Science, Colerain High School; Ray Carrara, Commercial Truck/Equipment Technology, Colerain Career Center

Main Components for Electrical Module

Making such a module is relatively easy. It is a project in which both academic and vocational instructors can share. (Or students who like hands-on work can be involved in its construction.) Once built, it can support a variety of instructional uses.

- Piece of 1/2″ or 5/8″ plywood, approximately 2′ x 3′
- Paint
- Wood or sheet metal screws
- Angle brackets for mounting the switch and motor (can be purchased at any hardware store)
- Single pole switch (available at any auto parts or electronics store)
- Two resistors, approximately 1.8 ohms (available at any auto parts store for about $1.50)
- Blower motor and squirrel cage (can be removed from scrap vehicles or purchased from an auto parts store for about $30)
- Trailer marker light
- 271-110 thermistor (available from electronics stores for about $2).

  The thermistor can be used to make a nice tool that can be used in conjunction with an ohmmeter to determine temperature changes.

  - ✓ Solder two light pieces of insulated electrical wire to the legs of the thermistor.
  - ✓ Run the wire through the tube of a discarded ballpoint pen, and hot-glue the thermistor into the end of the pen tube.
  - ✓ The ends of the wire should be protruding from the end of the tube opposite the thermistor. Fit the wire ends with small alligator clips.
- Electromagnet (can be constructed from light-gauge, insulated wire—preferably 20- or 22-gauge—wrapped around a bolt used for an iron core)

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Occupational Area: Construction Trades

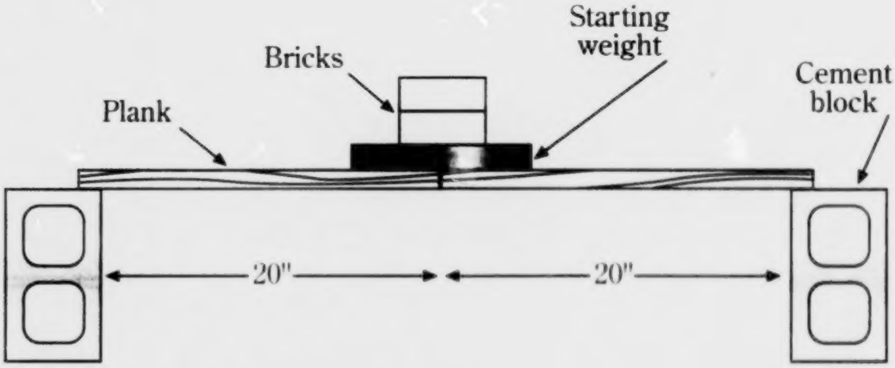
Academic Area: Applied Mathematics, Applied Science

Activity Topic / Skill Area: Which Wood Is Strongest?

Description of Workplace Context: Carpenters and architects may consider using a particular type of wood for its beauty, but first and foremost they must consider the wood's strength and function. Knowing relative wood strengths allows them to select the best wood for a proposed project.

Description of Related Classroom Activity: Students, working in teams of four, test three different wood types as follows:

- Find the center of the plank, and mark it with a line.
- Set the plank up on two cement blocks as shown below. Be certain the plank rests only 1″ on each block.



- Carefully place weights on the center line of each plank. Be careful to place the weight gently; don't drop it! Check with the teacher to determine the starting weight in order to save time.
- Record the weights placed on the plank. Stop when the plank cracks or breaks.
- Add up the individual weights to get the total wood strength.
- Convert inches, feet, and pounds to centimeters, meters, and kilograms using the conversion formulas provided. Chart your results; for each wood type, note the total weight held (lb, g, and kg).
- Work with teacher and classmates to compile team data into a single chart. Where team results vary, determine which results are correct.

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Conclusions:

- Based on the data, which wood held the most weight?
- Which wood tested was the weakest?
- Which wood might you choose as a support beam for a garage?
- If you needed to cut an intricate design into the wood, which wood would make this task most difficult?

Extension:

- What part of a tree trunk is responsible for a wood's strength?
- What other woods commonly used in the trade might you want to add to your wood strength chart?

Materials / Equipment:

- 6 planks of wood, of various types (labeled), each 1/2″ x 5″ x 42″
- 2 cement blocks
- 300 pounds of weight
- 12 bricks, individually weighed and marked
- 12 half bricks, individually weighed and marked
- scale, calculator, rule, and meter/yard stick

Authors: Ed Hughes, Construction Trades; Lynn Eckert, Chemistry; Bob Mavers and Mary Ann Wonson, Algebra/Geometry; Lakewood High School

Occupational Area: Construction Trades

Academic Area: Applied Mathematics, Applied Science

Activity Topic / Skill Area: Accurate Measurements

Description of Workplace Context: Measurements in science are never perfect. Carpenters, too, are expected to make accurate measurements, but you can only measure and interpret those measurements as accurately as your tools allow. Accuracy means the nearness of the measurement to the actual or accepted value.

Description of Related Classroom Activity: Students will carry out the following steps:

- Using only a pin, string, and 12" piece of wood, make a ruler that will measure items in **inches** only.
- Measure the items on the data table provided by the teacher. (The data table is a five-column table. Column 1 = the item. Column 2 is for recording inches. Column 3 is for recording half inches. Column 4 is for recording quarter inches. Column 5 is for recording eighth inches.)
- Record your measurements in the first column on the data table. For each item, record the measurement you are sure of (e.g., based on a measuring device that notes only inches); then add one more digit based on your best estimate (e.g., 1.5").
- Now take your ruler, and mark it off in **half** inches.
- Remeasure each item, and record your measurements (the digits you are sure of, plus one more digit you guess is correct) in the second column on the data table.
- Now mark your ruler off in **quarter** inches.
- Remeasure each item, and record your measurements as before.
- Finally, mark your ruler off in **eighth** inches.
- Remeasure each item one more time, and record your measurements as before.

Conclusions:

- Calculate the percent error for each of your ruler units by comparing your data with the true measurements provided by your teacher.

$$\% \text{ error} = \frac{\text{measured value} - \text{true value}}{\text{true value}} \times 100$$

- How close were your values to the true values?
- When your ruler was marked off in inches, did it measure small lengths very accurately?

Extension: Look up the history of measurement, and try to determine how many different standards of measurement have been used around the world.

Materials / Equipment: 12″ piece of wood, piece of string (approximately 12″), pin, list of objects to be measured, paper, pencil

Authors: Ed Hughes, Construction Trades; Lynn Eckert, Chemistry; Bob Mavers and Mary Ann Wonson, Algebra/Geometry; Lakewood High School

Electrical Trades

Occupational Area: Electrical Trades

Academic Area: Applied Math, Science, and Communications

Activity Topic / Skill Area: Passenger Elevator

Description of Workplace Context: Electricians, welders, carpenters, architects, etc., work together to build everything from toys to skyscrapers. Since no one is a master of all trades, each needs to draw on the expertise of the others and learn to respect their knowledge.

Description of Related Classroom Activity: Students will build the structure of a three-story elevator, scaled down to benchtop size. Once constructed, the elevator will be used as a Programmable Logic Controller (PLC) trainer—one allowing more advanced applications and more of a real-world feel than the simple PLC trainer currently available in the electricity lab. The elevator PLC project will allow students to have training in all aspects of mounting, connecting, and programming of PLCs.

The work is broken down into five phases. In each phase, instruction in math and science classes supports the work on the elevator shaft. For example, the applied academics teachers work with students on the study of torque, horsepower, pulleys, gear ratios, linear speed angles, etc.

- Phase I: Design and construct a three-story passenger elevator shaft. Students must research to determine the needed/desirable structural stability, functional operation, and appearance of the shaft. This should include a visit to a building with a multi-floor elevator to observe its structure and operation. Students also need to consult with students in other occupational areas (e.g., welding, drafting) to get the information they need in order to make design decisions.

- Phase II: Provide a means for moving the elevator car up and down the shaft and for identifying floor location.
- Phase III: Mount the PLC and associated equipment.
- Phase IV: Verify elevator operation by devising a simple program, entering it into the PLC, and testing its operation. Based on the results, make any revisions or improvements needed to the structure or operation.
- Phase V: Write an operations manual for the elevator (applied communications). This should not explain how to wire or program; it should simply explain normal operation of the elevator. For example, the manual should describe how the car will respond to switch commands, as well as operations for having the car respond differently (time delays between floors; excluding floors if special code/key is not used, etc.).

Materials / Equipment: 1″ lightweight tubing, sheet metal, motor and gear box, PLC, PLC programmer, misc. limit switches, toggle switches (The frame could be made of wood, which would be less expensive.)

Extended Activity: Other applied communications ideas include (1) having students jointly develop an operation, maintenance, and safety manual for the elevator; (2) having each student write a paper—Why an Elevator Comes When You Call It—explaining the complicated switching involved in elevator operation; and (3) having students give oral presentations on the electrical/mechanical operations of the elevator.

Author: Ken Gebhart, Electrical Trades, Washington County Career Center

Occupational Area: Electrical Trades

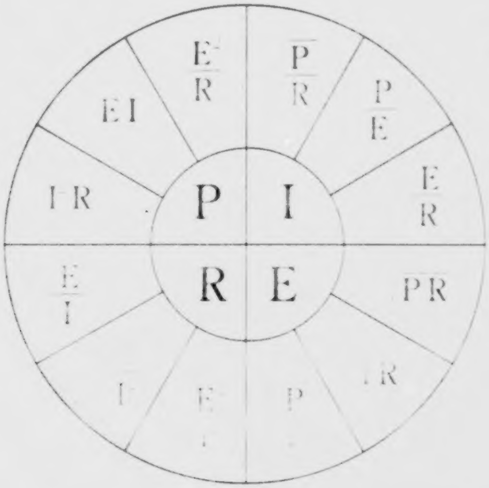
Academic Area: Applied Mathematics, Applied Communications

Activity Topic / Skill Area: Programming Power Wheel Formulas

Description of Workplace Context: Workers must employ analytical problem solving on the job. Programming activities help to develop skill in this area.

Description of Related Classroom Activities:

- Electricity Class: Review of the concepts of power, resistance, amperage, and voltage.
- Communications Class: Following instruction in the elements of a good definition, students write definitions for ***power***, ***amperage***, ***voltage***, and ***resistance***.
- Math Class: Following a review of power wheel formulas (shown below) and basic programming concepts, students write a basic program capable of solving each of the twelve formulas.



The program must also define amperage, power, resistance, and voltage and give the user exit options.

Students input the introduction and first two sections of the program using a model provided by the teacher. They work collaboratively in teams to write the third section of the program; they work independently to produce the fourth section.

Lesson Results: Students really needed more practice in the computer lab with simpler programs before writing the "big" one. The program also needs to be modified to have the capacity to change units to a metric base for the user.

Authors: Charles Pomroy, Applied Communications; Linda Burrell, Applied Math; Ken Gebhart, Electrical Trades; Washington County Career Center

Occupational Area: Electrical Trades

Academic Area: Applied Mathematics, Applied Communications

Activity Topic / Skill Area: Writing and Reading Directions

Description of Workplace Context: Workers in all occupations must at times follow a specific set of directions to successfully complete an assigned task. Likewise, they must sometimes explain to others how to complete a particular task, and their explanations must be clear, complete, and accurate.

Description of Related Classroom Activity:

- Electricity Class: Following instruction on how to wire 3-way switches, students practice this skill.
- Communications Class: Instructor explains the process for writing directions and gives examples of informational process papers. Each student then develops an illustrated set of instructions for wiring two 3-way switches to a single light fixture.
- Math Class: Instructor helps students develop a materials list and cost breakdown to accompany the directions.
- Evaluation: Students exchange their drafts and critique each other's work. They then revise as necessary before handing them in for evaluation. Each paper is evaluated by the communications teacher (effective organization, adequate development, etc.); by the electricity teacher (technical accuracy and safety); and by the math teacher (materials list and cost breakdown).

  The paper judged to be "best" is given to a novice who is asked to perform the task with only the student's illustrated directions to guide him or her. The experiences of this person in trying to follow the directions are used as the basis for a class critique.

Lesson Results: Students debated sharply among themselves concerning the correct approach to use in wiring the switch. This helped them clarify in their own minds what was to be done and how best to approach the assignment. As for the novice's performance, the school's director successfully completed the task using the student's directions.

Authors: Charles Pomroy, Applied Communications; Linda Burrell, Applied Math; Ken Gebhart, Electrical Trades; Washington County Career Center

Occupational Area: Electronics, HVAC, Electricity

Academic Area: Science

Activity Topic / Skill Area: Thermistor (temperature–sensitive resistor); Temperature-Sensitive Devices

Description of Workplace Context: Any climate or temperature-control device must be temperature-sensitive. The student must understand the science principles employed in these devices.

Description of Related Classroom Activity: During the thermocouple lab, introduce other temperature-sensitive devices. The thermistor resistance can be measured at ambient temperature. Then ask the students to pinch the thermistor, changing its temperature ΔT. Resistance will change. Construct a simple circuit using a power supply, thermistor, and load. Measure voltage at ambient and voltage with ΔT caused by student pinching thermistor. Talk about other devices that are temperature/humidity-sensitive.

Materials / Equipment: Thermistor, power supply, load

Authors: Mike Pottmeyer, Science; Don Foster, Electronics; George Combs, HVAC; Springfield-Clark County JVS

Occupational Area: Electronics

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Digital Electronics / Boolean Algebra

Description of Workplace Context: Design a Digital Circuit

Description of Related Classroom Activity: Given three or more logical conditions, student will develop a truth table, design a logic circuit, use Boolean algebra / Karnaugh maps to find the simplest circuit.

Author: Dianne Light, Applied Mathematics, Springfield-Clark County JVS

Addendum: David Cairns, applied mathematics teacher at Warren County Career Center, suggests the following variations on this plan:

- Electronics: Students wire a "silly" circuit with too many logic gates and observe the outcome.
- English: Students log lab activity and express their thoughts on the validity of the circuit.
- Math: Teacher goes through digital network simplification via K-map and Boolean algebra and guides students in breaking logic down to its simplest form.
- Electronics: Students rewire the simplified circuit and prove the results are the same.
- English: Students log new activity and express their thoughts on why the simplification works.
- Math: Students write a logical sequence of the simplification instructions for others to follow.
- Evaluation: Teachers evaluate the project as a team.
- Recycling: Project recycles (new gates, negative logic, Demorgan's laws, etc.).

Occupational Area: Electronics

Academic Area: Applied Math, Applied Communications

Activity Topic / Skill Area: Computer Networking

Description of Workplace Context: Networking is an essential part of communications in the global world of business today. The client/server concept provides a means of communicating between a remote location and a central location (the server). Technicians need to be able to network two or more computers and explain the rudiments of the system in lay language to a customer not versed in electronic technology.

Description of Related Classroom Activity: Some students recently had the opportunity to work with the electronics instructor to network the school. This hands-on experience was used as a motivator to teach new skills to the whole class.

- Electronics Class: After receiving the needed instruction, students actually networked two computers in their lab.
- Applied Math Class: Instruction focused on the theories and formulas needed for wire schemes, transfer rates, impedance, wire sizes, capability, and selection.
- Applied Communications Class: Instruction focused on network terminology (an extensive list was provided by the electronics instructor). Students practiced "translating" electronic jargon into lay language. This not only reinforced the importance of talking to customers in a way that communicates, it also solidified students' knowledge of the concepts involved.
- Culminating Activity: Class members had to explain the network to three instructors role-playing customers who lacked technological expertise.

Materials / Equipment: Two PCs with Ethernet interface cards; WFW3.11 or WIN95; 8-port hub; two 10BaseT 6' cables; networking tools; network vocabulary list

Estimated Time: One week to build network

Authors: Jean Benning, Applied Communications; Tom Newman, Electronics; David Cairns, Applied Mathematics; Warren County Career Center

Occupational Area: Electronics

Academic Area: Applied Math, Applied Communications

Activity Topic / Skill Area: Customer Service

Description of Workplace Context: Electronic technicians initially engage customers on the telephone. If the technician cannot talk the customer through problem solution over the phone, a service call may be made. Troubleshooting skills are critical. Keeping records (e.g., work orders, bills) is also part of the job. Thus, customer service is a natural for academic-vocational integration.

Description of Related Classroom Activity:

- Electronics Class: Students will learn troubleshooting skills.
- Applied Math Class: Students will learn to use spreadsheets, including file management and the software's integrated database. Spreadsheets provide the most efficient method for maintaining records (work orders/bills). And with customer records keyed into a database, technicians can immediately retrieve them while speaking to customers on the phone. By including customer status in the database, weekly sweeps can identify delinquent accounts. Students will create an efficient work order/bill (including materials cost, labor charge, tax, and total) using the spreadsheet software.
- Applied Communications Class: When you are trying to provide technical support, it can be difficult to retain your composure if the customer is angry. If you forget that the average layperson is not necessarily technically proficient, you might make statements that confuse or offend the customer. Thus, students will work on proper telephone etiquette and techniques for diffusing a difficult situation. They will also design a work order and practice completing it in a way that is professional-looking (correct spelling and grammar, understandable abbreviations) and readable.

Materials / Equipment: PC (486 or higher, 8 MB of RAM or higher; a laptop is desirable for the technician); spreadsheet/database software (e.g., Quatro Pro or Excel); troubleshooting/repair toolbox

Estimated Time: This is a year-long project to be worked on intermittently. Simulations could take place at random times during the second semester.

Extended Activity: When students are sufficiently prepared, an in-school simulation could take place. A piece of school equipment could be sabotaged by the vocational teacher. When the problem is discovered and someone calls the electronics lab for technical support, a selected student would have to handle the call, applying all the skills learned in vocational and applied classes. At the end of the simulation, the customer would be asked to complete a technical support evaluation form (a rubric) and send it to the vocational lab. The technician would be graded on troubleshooting skills, telephone/customer interaction, and record keeping.

Authors: Jean Benning, Applied Communications; Tom Newman, Electronics; David Cairns, Applied Mathematics; Warren County Career Center

Electronics

Occupational Area: Electronics

Academic Area: Applied Math, Science, Communications, Employability, Technical Related

Activity Topic / Skill Area: Development of Multimedia Recruitment Slide Show

Description of Workplace Context: Multimedia presentations are an important part of sales and service programs in the business world.

Description of Related Classroom Activity: Seniors in the electronics program created a presentation/slide show to be used as a tool in recruiting eighth and ninth graders for vocational programs. The math instructor, who was familiar with the presentation software, coordinated the project. The applied communications and electronics teacher provided editing and technical support. Students videotaped faculty (both vocational and applied academics), administration, and students in various scenes and then used audio to tie the presentation together as a promotional tool. The students researched and created information slides and chose music to accompany the show. They then edited the slides, voices, and music into a short recruitment package.

- Applied Math Class: Student activities focused on organizational skills. By hyperlinking text (HTML), loops can be made to connect different portions of the slide show. The sequence of the slide show needs to be charted and diagrammed before it is created. If any looping is done, a flowchart must be utilized. These skills were taught in the applied mathematics course.

  [illegible] Students edited all slide text and .WAV files to ensure that they were grammatically correct and socially acceptable. If scripting were to be done, this would be a natural for the communications class.

Materials / Equipment: Presentation software (e.g., Microsoft Powerpoint or Corel Presentations); PC (486 or higher, 16 MB of RAM or higher, sound card with speakers); flatbed color scanner; tape recorder with patch cord for PC; camera/film

Estimated Time: This is an ongoing project to be worked on intermittently and completed by the end of the first semester.

Lesson Results: More scripting was needed; there was too much repetition when speakers were given a free hand.

Extended Activity: If every program developed its own slide show, they could be compiled onto a network or stand-alone PC in the main office or entryway to the building. Using the HTML technology, anyone could walk into the building, click on a vocational program, and view a multimedia slide show about that program, prepared by actual students from that program.

Authors: Jean Benning, Applied Communications; Tom Newman, Electronics; David Cairns, Applied Mathematics; Warren County Career Center

Occupational Area: HVAC, Auto Body

Academic Area: Applied Mathematics, Applied Communications

Activity Topic / Skill Area: Measurement, Ratios, and Writing and Reading Directions

Description of Workplace Context: Both vocations employ measurement and giving/following directions.

Description of Related Classroom Activity: HVAC students are to construct with poster board a duct of specified dimensions (several different per class). After completion, they are to write instructions on making these ducts so that a non-HVAC person can follow and construct.

Auto body students are given the task of mixing "paint" (really colored water). They need to know total volume required, how many parts paint, lacquer thinner, hardener, etc. They are to mix the solution according to proportions given. After completion, they are to write instructions for mixing the paint that a non-Auto Body student can follow.

Now both classes trade directions. The Auto Body students build ducts and the HVAC students mix paint. If the duct or paint directions are not usable (e.g., are unclear, incomplete, or confusing), the author of the directions will need to rewrite.

Materials / Equipment: Colored water, measuring cups, rules, heavy-duty poster board, scissors or X-Acto knife (Note: It takes a lot of trial and error to get the colors so that the project—color of final mix—can be graded by sight.)

Estimated Time Required: 2 class periods

Author: Melissa Nelson, Applied Mathematics; Springfield-Clark County JVS

Occupational Area: HVAC

Academic Area: Science / Applied Mathematics

Activity Topic / Skill Area: Calculating Cubic Feet Per Minute (CFM)

Description of Workplace Context: The HVAC technician must determine the CFM of a gas furnace. The data obtained will be used to balance the system's climate control.

Description of Related Classroom Activity: The students will be given the formula—

$$\text{CFM} = \frac{\text{BTU/H}}{\text{Temp. Rise x 1.08}}$$

Start with an understanding of where to find BTU/H (consumption rate). The gas heating value is given by the local gas company as 1040 BTU per cubic foot. The furnace entering air temp is 75°DB and the leaving temp is 135°DB. The furnace is rated at 75% steady state efficiency.

The furnace is moving about 1200 CFM.

Materials / Equipment: None

Estimated Time Required: 50 minutes

Authors: Mike Pottmeyer, Applied Science; George Combs, HVAC; Springfield-Clark County JVS

Occupational Area: HVAC

Academic Area: Science / Applied Mathematics

Activity Topic / Skill Area: Determine Total Capacity

Description of Workplace Context: Technicians need to determine the total capacity of an air conditioner to establish its efficiency.

Description of Related Classroom Activity: With a wet bulb thermometer, take the temperature of the air entering and leaving the evaporator. Take average readings. Example: Entering 68°WP. Leaving 62°WP.

At this point, you have to took at an enthalpy chart. These are psychrometric charts. What you're determining here is the enthalpy (BTU per pound of dry air) of the two wet bulb readings. The chart shows that 68°WP = 32.42 enthalpy and 62°WP = 26.46 enthalpy.

Subtract the enthalpy readings: 32.42 – 26.46 = 5.96

You also need to know how many pounds of air the unit is moving. There are 13.33 cubic feet of air in one pound. The unit is moving 800 cu ft/min. 800 ÷ 13.33 = 60.16/min. Thus, in one hour the unit will move 60 x 60 = 3,600 lb of air.

Multiply the pounds per hour by the enthalpy difference. 3600 (pounds of air per hour) x 5.96 (enthalpy) = 21,456 BTUs per hour.

Materials / Equipment: Wet bulb thermometer, dry bulb thermometer, psychrometric/enthalpy chart

Authors: Mike Pottmeyer, Applied Science; George Combs, HVAC; Jennifer Souders, Applied Mathematics; Springfield-Clark County JVS

Occupational Area: HVAC

Academic Area: Science / Applied Mathematics

Activity Topic / Skill Area: Ohm's Law

Description of Related Classroom Activity:

Mathematics Instruction (Junior Year)

- Teach basic linear equations and how to use formulas
- Discuss basic electrical concepts
- Demonstrate how to use the "magic circle" of Ohm's law
- Teach how to manipulate the formula for Ohm's law
- Present applications of Ohm's law to HVAC

Science Instruction (Senior Year)

- Review basic electrical concepts
- Review the "magic circle" of Ohm's law
- Solve problems using Ohm's law
- Conduct demonstrations that illustrate resistance in an electrical circuit
- Demonstrate the association between voltage, amperage, and resistance
- Have students conduct experiments using Ohm's law
- Teach how to read electrical multimeter

HVAC Instruction (Junior and Senior Years)

- Guide students in using Ohm's law to determine the total resistance of a residential heating or cooling system
- Teach how to troubleshoot electrical components used in air conditioning or furnace equipment

Authors: Mike Pottmeyer, Applied Science; George Combs, HVAC; Melissa Nelson, Applied Mathematics; Springfield-Clark County JVS

Occupational Area: Home Improvement

Academic Area: Applied Science, Applied Communications

Activity Topic / Skill Area: Personal Fall Arrest Systems (PFAS)

Description of Workplace Context: In home improvement projects, there is a real danger of falling. Personal safety and awareness of the importance of using PFAS need to be the responsibility of each worker.

Description of Related Classroom Activity: The home remodeling, applied science, and applied communications teachers will each provide information in their classes on PFAS.

- Home Remodeling Class: The teacher will demonstrate the PFAS in class and have students practice working with these systems (e.g., safety harnesses, scaffolding construction). Background information will be provided on the need for PFAS, conditions warranting their use, and OSHA regulations regarding their use. Each student will practice using a safety harness in the lab before using one on the job site.
- Applied Science Class: At the beginning of their junior year, students will do hands-on labs to determine the mechanical advantage of simple machines (e.g., pulleys), center of gravity, and forces. Vectors could also be used to determine equilibrium and net forces. Students will construct and test model scaffolding to determine proper construction for maximum strength and safety. Reading materials (home remodeling text, OSHA regulations) will be incorporated as well.
- Applied Communications Class: Students will do outside research on PFAS using manuals, trade journals, and texts. From this and information provided in their other classes, each student will write a summary to add to the manual and present the summary to the class using demonstrations, transparencies, and other visuals. By videotaping the presentations, all three teachers will be able to evaluate them. A checklist with a five-point rating scale has been prepared for this purpose.

Students will then compile the information from these classes and from their own research into a personal safety manual. Each student will also present an oral summary of what he/she has learned.

Authors: Rick Stephens, Home Remodeling/Carpentry; Bonnie McQuown, Applied Communications; Lynn Cooke, Applied Science; Pioneer CTC

Occupational Area: Plumbing

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Application of Math to World of Work

Description of Related Classroom Activity:

- Step I: Pick a Topic. Each group of students will pick a procedure from mathematics class that can be related to their vocational field. The selected topic must be approved by the teacher.
- Step II: Preparation. Each group will be given two weeks to prepare a group presentation on the selected topic. Students can use textbooks and other resources to work out formulas and find trade applications. Both the mathematics and plumbing teachers will serve as resources for student efforts.
- Step III: Presentation. The presentation will consist of four parts: (1) to teach the math procedure, (2) to explain how it relates to the vocational area, (3) to-provide a related mathematical problem from the vocational area and show how to solve it, and (4) to give examples of how this procedure is used in other vocational areas.

Lesson Results: When the teaching team tried out this plan, the results were not as positive as they had hoped. They have three recommendations for improving the activity in the future: (1) students need more teacher assistance in developing their presentations; (2) the presentation needs to start with a vocational problem and apply mathematics in its solution rather than starting with the mathematics concept; and (3) students need to be asked to use visual aids in their presentations to aid in understanding.

Authors: Rick Hupe, Plumbing; Mike Meyer, Applied Mathematics; Four County JVS

Occupational Area: Plumbing

Academic Area: Applied Mathematics

Activity Topic / Skill Area: Bridge-Building Project

Description of Workplace Context: Plumbers need to be able to follow specifications, demonstrate teamwork, use critical thinking and problem-solving skills, and use construction techniques to ensure the strength of the final product.

Description of Related Classroom Activity: Students in mathematics class work in teams to design, draw, and build a bridge according to given specifications:

- Maximum length: 16″
- Maximum width: 4″
- Maximum height: 8½″
- Span: Must span a 10″ river with no center supports.
- Clearance: Must have at least 4″ clearance above water at the center.
- Support: Must be freestanding (not fastened to any base).
- Strength: Must provide an area 1″ x 4″ at center of bridge for adding weights to test for strength.
- Neatness: No glue may be showing.

In building the bridges in mathematics class, students use measurement skills, practical geometry, interpretation of specifications, teamwork, creativity given limited resources, critical thinking and problem-solving skills, and basic construction techniques.

In plumbing class, the teacher discusses the need for and importance of meeting specifications and measuring accurately on the job.

Both teachers judge the completed bridges according to six criteria: beauty of design (20 points maximum), creativity (25 points), adherence to specifications (50 points), neatness of construction (25 points), and strength (2 points for each pound that the bridge supports, up to 50 lb).

Those bridges that survive the strength test are put on display. Those that do not survive are taken to plumbing class where the construction techniques are evaluated and discussed. Bridges can then be redesigned and new drawings submitted to show needed improvements in construction.

Materials / Equipment: Per bridge—2 boxes of flat toothpicks, 25 craft sticks, and baby food jar of wood glue

Authors: Rick Hupe, Plumbing; Mike Meyer, Applied Mathematics; Four County JVS

Occupational Area: Welding

Academic Area: Applied English III / Social Studies

Activity Topic / Skill Area: Research / Referencing

Description of Workplace Context: Business and industry are now part of a global paradox whereby the smaller company is a major team player in the final product. An awareness of the global ties of local manufacturers becomes visible with global identification and mapping.

Description of Related Classroom Activity: During the student internship, students are to compile a list of the business's major customers, clients, suppliers, etc., and their geographical locations. (Students might discover that a small-town business subcontracts for a St. Louis firm that is working on a job for Beijing, China.)

Armed with this information, students will return to the English classroom and, using reference tools, locate the towns and/or states and/or countries on a wall map. Students will also create a legend for the map, color-coding pins/flags to the business and its customers, clients, subcontractors, etc.

Materials / Equipment: Reference materials (encyclopedias, computers with related software, wall map, identification pins)

Estimated Time Required: Class Period

Authors: Ken Kirby, Welding; Cathy Deardoff, Applied English; Manchester Technical Center

Occupational Area: Welding

Academic Area: Applied English III

Activity Topic / Skill Area: Team Building (interviewing, listening skills, speaking skills)

Description of Workplace Context: Team building is a major component of business and industry. Working together develops pride in the product and ownership of its success. Teaming is an activity that builds on a multitude of experiences and the exchanging of roles within the team.

Description of Related Classroom Activity: For the purpose of the student internship, teams of 3 or 4 students will be created. Within each team, roles will change at each site. The team roles will be—

- interviewer: asks questions of the site host
- recorder: records answers, takes notes, etc.
- safety inspector: identifies and records examples of good safety practices, locations and visibility of fire extinguishers, first aid stations, etc.

Materials / Equipment: Pen/pencil, paper, prepared "data discovery" sheet

Estimated Time Required: Length of internship visit

Authors: Ken Kirby, Welding; Cathy Deardoff, Applied English; Manchester Technical Center

Occupational Area: Welding

Academic Area: Applied English / Applied Mathematics

Activity Topic / Skill Area: Developing Graphs; Locating Information; Reading for Information

Description of Workplace Context: Newly hired workers need to gather information from worksites on attendance, pay scales, and processes.

Description of Related Classroom Activity: Through a teaming procedure, students will gather worksite information as outlined by participating teachers. They will then develop graphs in Applied English to compare and contrast information gathered from various worksites. These graphs will include information on employee attendance and the individual student's attendance, which will also be compared to various worksite attendance policies. Processes used at various sites will also be graphed to compare and contrast such factors as pay scales, number of employees, gender, etc. This will allow students to measure their present performance to real-world industry standards/expectations and give the students a better picture of the industry they plan to enter.

Materials / Equipment: Pen/pencil, data gathered, paper, graphics software program and computer (optional)

Authors: Ken Kirby, Welding; Cathy Deardoff, Applied English; Manchester Technical Center

Occupational Area: Welding

Academic Area: Applied English III / Applied Mathematics

Activity Topic / Skill Area: Writing (organizing facts, details, and examples in logical order)

Description of Workplace Context: In the welding shop, the paper trail is sometimes as important as the product. Time on task equates to quality control, quality assurance, and ultimately profit. The welder must provide as much information as possible on the job order to correctly charge the job. The weekly log is designed as a preliminary step to the work order job description.

Description of Related Classroom Activity: Using the Student Weekly Log (attached), complete the following steps:

Step One

- Fill out general information.
- Write legibly.
- Use correct spelling.
- Demonstrate completeness in all written materials.
- Organize facts and details in logical order.

Step Two

- On a daily basis, record jobs performed, skills learned, and questions you have in the appropriate areas on the form.
- Record starting and stopping times for each day (rounded to the nearest half hour).
- Omit Saturday and Sunday.
- Total hours for the week.
- Multiply hours x hourly rate (as assigned by teacher) to obtain Gross Wage.
- Sign your log sheet and date it.
- Submit log sheet to vocational teacher for additional comments and signature.
- Vocational teacher will submit to Applied English teacher for final evaluation.

Materials / Equipment: Handout

Authors: Ken Kirby, Welding; Cathy Deardoff, Applied English; Manchester Technical Center

STUDENT WEEKLY LOG

Student ______________________ Employer ______________________

Report for Week of ________ to ________ Supervisor ______________ Phone __________

JOBS I PERFORMED THIS WEEK	NEW SKILLS OR INFORMATION I LEARNED THIS WEEK

CONCERNS / QUESTIONS / PROBLEMS I HAVE

	Time Started Working	Time Stopped Working	Number of Hours Worked
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			
Saturday			
Sunday			

Total Hours ________ x Hourly Rate ________ = Gross Wage ________ Days Absent ______ Days Late ______

Instructor / Employer Comments

Student Signature ______________________________ Date ______________

Instructor/Employer Signature ______________________________ Date ______________

Occupational Area: Any Vocational Program

Academic Area: Applied Math, Science, Communications

Activity Topic / Skill Area: Tour of a Work Site

Description of Related Classroom Activity:

- Applied Communications Class: Students research a place to visit, select a place, and write to that company requesting permission to visit and inquiring about safety requirements at that particular site. Students could also invite someone from the company to come to class to talk about the company and its products. After a brainstorming activity concerning what students want to see and learn during the visit, they prepare interview guides for the trip.
- Applied Math Class: Student activities focus on the types of jobs performed at that company involving math (e.g., payroll, inventory, schedules, charts, and records).
- Applied Science Class: Instruction covers subjects related to the products the company produces. For example, if students are to tour a plastic or stamping plant in which different types of plastics are used, students could study the way in which they are used for injection or blow molding and the mixing of color in plastics.
- Occupational Class: The vocational teacher covers concepts and tasks related to the company's product (e.g., plastic mold-making, use of different steels, working part of a mold).
- The Visit: Students compare what they see with what they learned in class, keeping notes of their findings. They ask questions using their interview guides.
- After the Visit: Students discuss what they did and saw and how it differed from what they expected. They write thank-you notes.

Authors: Jim Davis, Precision Machining; Sophie Garrity, Applied Science; Belmont-Harrison JVSD

The Information Superhighway

The Information Superhighway

If you are already jogging down the Information Superhighway, you can skip ahead to the curricular resource list, which begins on p. 159. If not, the following is a simplified explanation of what it is and what it has to offer.

The Information Superhighway is an extraordinary access route to an enormous amount of information. These days, everyone and his or her uncle is putting up a Webpage on the Internet or World Wide Web, accessible by a URL. But what do these terms mean?

The Internet

Originally established during the Cold War as a mechanism for ensuring defense-related communication nationwide, the Internet has become a mega-network comprising—and allowing access to—other large and small networks.

When used in a nongraphical environment (think of IBM without Windows), the Internet was accessible mainly to those with significant computer skills. The rest of us could access only the tip of the iceberg. With a graphical environment (Macintosh or Windows) and the Net software available today, Internet access is quite easy and friendly.

The Web

Now, what about the *World Wide Web* (or simply, the *Web*)? Think of a spider's web—concentric circles connected with multiple cross-hatching. That's what the World Wide Web is like. It links documents together and allows you to contact one site and then connect to other related sites with a mere click of a graphic button (*surfing* the Net).

In subsequent pages in this section, we will look at some of the specific Websites that users have recommended relating to vocational education and applied academics. This list is not extensive, and there's a reason for this. The Web changes constantly. Any print list is soon out of date. But not to worry! There are numerous search engines and sites whose sole job is to get you where you want to go on the Information Superhighway. Thus, the first list of sites at the end of this explanation will be those designed to help teachers locate additional sites of interest to them.

Navigators and Search Engines

A *navigator* is software (e.g., Netscape) that, as its name suggests, allows you to navigate the Web. The navigator may be provided by your Web service, or you can buy the software yourself.

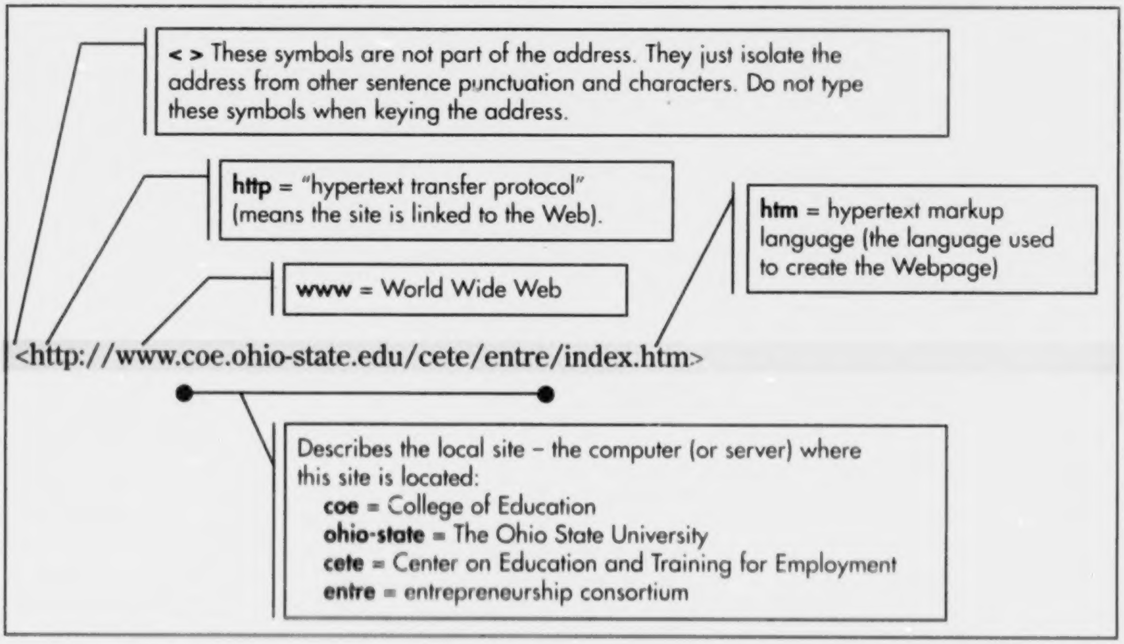
Search engines in the navigator (e.g., Magellan, Excite, Yahoo, Infoseek, Lycos) allow you to search an index of Internet subjects. Using one of these free devices, you simply key in the term(s) you want to search and it does the work. Most search engines provide help or search tips to aid you in locating the desired information, and most allow you to modify and narrow your search as you go along. The results display as a list of items, usually sequenced according to how likely they are to be relevant. You can then scan the list to see if you've gotten a "hit."

In the lists of Websites shown later in this section, you will find some search engines designed specifically to locate resources for educators. But even the general search engines usually allow you to pick a general subject such as *education* first before commencing your specific search.

URLs

It is not necessary to use a search engine if you know the site's actual address—it's URL, which means "uniform resource locator." As an example, let's decipher the Website address for the International Consortium for Entrepreneurship Education:

<http://www.coe.ohio-state.edu/cete/entre/index.htm>



< > These symbols are not part of the address. They just isolate the address from other sentence punctuation and characters. Do not type these symbols when keying the address.

http = "hypertext transfer protocol" (means the site is linked to the Web).

htm = hypertext markup language (the language used to create the Webpage)

www = World Wide Web

<http://www.coe.ohio-state.edu/cete/entre/index.htm>

Describes the local site – the computer (or server) where this site is located:

coe = College of Education
ohio-state = The Ohio State University
cete = Center on Education and Training for Employment
entre = entrepreneurship consortium

Webpages and Homepages

A *Webpage* is everything at your Website—a misnomer since it's often more than one page. A *Homepage* is like a home base for the *Website*. It often gives a brief description of the individual or the organization that established the site, a menu of its contents, and descriptors you can click for more information on particular topics.

These days, the problem is not so much finding what you want—it's trying to stay focused. So much is available that you may spiral from one link to another, disappearing for hours or days as you peruse the fascinating contents of the Net.

- When you pick up a magazine, you're likely to see a Web address where you can get information or send e-mail to express an opinion.
- On TV, networks and programs often list a Web address for use by viewers. There are sites for new movies, fan clubs, sports teams, news organizations, and advertisers.
- Do you want to see what publications are available from a publisher? Just use a search engine to access its Website and search the catalog.
- Want to know what's happening of relevance to teachers at the National Science Foundation?
  - ✓ National Science Foundation: <http://www.nsf.gov>
- Want to contact your professional association?
  - ✓ National Education Association: <http://www.nea.org>
  - ✓ American Federation of Teachers: <http://www.aft.org>
  - ✓ American Vocational Association <http://www.avaonline.org>
  - ✓ National Council of Teachers of English: <http://www.ncte.org>
  - ✓ National Council of Teachers of Mathematics: <http://www.nctm.org>
  - ✓ National Science Teachers Association: <http://www.nsta.org>

- Want a web site for auto technology educators?
  - ✓ International Auto Tech Network: <http://www.i-atn.com/auto>

Notice the pattern in those Web addresses? Sometimes you don't need a search engine, just a little common sense. Acronyms are often used in addresses, followed by a descriptor of the type of entity:

- Organizations = *.org*
- Government agencies = *.gov*
- Colleges and universities = *.edu*

E-mail

E-mail is "electronic mail"—messages that arrive at your computer when sent to your electronic mailbox address. (Your service provider will usually help you devise an acceptable mailbox address.) E-mail software (e.g., Eudora or Eudora Pro) allows you to access and transmit e-mail messages.

E-mail can have enormous benefits. Individuals used to spend hours playing telephone tag—calling and returning calls without ever reaching each other. Now an e-mail message can be sent directly to that individual, who can then respond at his or her earliest convenience.

The ease of communication is probably its chief benefit. Consider this example. Assume you are a new English teacher and some of the mail that arrives in your school mailbox (catalogs and such) is addressed to your predecessor. If you have to write or call to request that such mail now be addressed to you, you may not get around to it. If all you have to do is send off a quick e-mail message from your computer, you are much more likely to do it.

Or consider international communication. Americans with business dealings with countries behind the Iron Curtain used to have a terrible time making contact because the phone systems were so archaic and because the time zone differences are so vast. As organizations and individuals in those countries have begun to come online, the ability to communicate has eased enormously.

Whereas an Internet, or Web, address gets you to a computer site and its contents, an e-mail address reaches a live human being. If, for example, you want to contact someone at Ohio's Vocational Instructional Materials Laboratory to ask a question or request a catalog, you can simply send an e-mail message to <viml@osu.edu>. Many Websites provide an e-mail connection (i.e., click here to send an e-mail message to the originator of the site).

When you subscribe to a *newsgroup* (described below) that supports teacher chat, you will often find opportunities for Net pen pals. For example, a teacher, perhaps in Singapore, might give an e-mail address and ask for messages from American students. It is a small world after all.

Usenet Newsgroups

Newsgroups are established groups—or bulletin boards—related to a specific topic, to which Internet users can subscribe. Some are read-only news groups produced by news services (e.g., *clari* groups from Reuters). Some are for discussion—either open (no one's in charge) or moderated.

Searching for Newsgroups

If you have friendly software (e.g., Trumpet Newsreader), you can easily search the available open groups (and they are legion) using key words. For example, key words such as *teacher, science, math, english* (yes, english, not English; the search is case-sensitive), and *education* recently "fingered" the following groups:

k12.chat.teacher
misc.education
clari.news.education
clari.news.education.misc
clari.news.education.releases
sci.math
sci.math.num-analysis
sci.math.research
sci.math.symbolic
k12.ed.math

k12.ed.science
clari.tw.science
clari.tw.science+space
misc.education.science
sci.space.science
k12.lang.art
alt.usage.english
misc.education.language.english

Many of the Websites listed later in this section were found in the newsgroup k12.chat.teacher. People in this group share information of potential interest to the group, express opinions, or ask for help in a particular area.

Subscribing

Today's friendly software makes accessing the newsgroups easy. For the most part, to "subscribe" you simply select the groups you want to follow. Subsequently when you open up the program, a list will appear of the groups to which you have subscribed. The program will let you scroll through the groups to see what messages have arrived. As each group is accessed, a list will appear of all messages received. Each is identified by its subject line, which allows you to get an idea of whether you want to read it or not.

Be advised: New users always want to subscribe to all groups even remotely of interest and to read all messages received. You cannot maintain this pace and keep your sanity (or your friends and family). Be selective in the groups you pick and the messages you choose to actually read. Particularly when a group is not moderated, there can be a tremendous amount of junk (or even offensive material) posted to the group.

Netiquette and FAQs

There are protocols (called *Netiquette*) for using these discussion groups, and if you violate these protocols, you can expect to be *flamed*—messages intended to slap your hand or, worse, insult your intelligence, will be posted publicly online. Your service provider should automatically subscribe you to a group for new users, which will regularly repost articles about protocols, procedures, and answers to *FAQs* (frequently asked questions). If you wish to be a knowledgeable participant—and to avoid being flamed—it is critical that you read them!

Mailing Lists

Like the Usenet Newsgroups, mailing lists allow Internet users who share an interest to participate in a discussion group. What are the differences? Fewer mailing lists are available; they are not listed neatly in one place for you to pick from; and you can only "chat" on one if you ask to subscribe and are accepted.

How Mailing Lists Work

A software program (a *listserver*) receives all messages sent to the list and redistributes them to all the subscribers. Each mailing list has two addresses: one where you send a message asking to subscribe; the other where (once accepted) you send messages to be redistributed. (You can always tell a rookie when you open the mailing list messages and find one focused not on the subject but, instead, asking to subscribe.)

VOCNET

One mailing list relevant to teachers of vocational education and applied academics is VOCNET maintained by the National Center for Research in Vocational Education at Berkeley. To subscribe, send an e-mail message to <listserv@cmsa.berkeley.edu>. The message should read (no more, no less):

> subscribe vocnet *yourfirstname yourlastname*

Once the moderator tells you you've been accepted, VOCNET will become one of your subscription newsgroups. You will receive all messages sent to the group and can reply or initiate your own messages. When you are within that listserv newsgroup and click REPLY or MAIL, these messages will be automatically addressed to the second mailing list address: <bit.listserv.vocnet>.

Internet Access

To access the Internet, you will need equipment, software, and an account.

- ***Equipment.*** Basic equipment includes a computer and a modem (a device for allowing your computer to connect to other computers over the phone lines).

  One caution about computers: As more and more Websites are built that are graphically sophisticated or that contain access to huge catalogs, you will need a computer with enough speed and memory to deal with it. Older machines with minimal memory are prone to freeze up, shut down, or send error messages when you try to access a site with more content than your computer can handle. You can *download* (move the content from the Website to your own computer) a great deal of material—even movies and videos—if you have the equipment capability and the time.

- ***Software.*** You will also need communication software for the various functions (e.g., Netscape Navigator, Eudora, Trumpet Newsreader). Some software can be downloaded free of charge once you have gained access.
- ***Account.*** Next you need a phone number for your modem to call to establish contact.
  - ✓ If you are taking courses at a university, you may have an Internet account through the university. Or your school may provide Internet access.
  - ✓ If not, you will probably have to subscribe to a commercial online service, either national (e.g., America Online, CompuServe, Prodigy) or local. Service providers will charge you either a flat monthly rate or a base rate plus additional for extra usage.
  - ✓ Freenet may also be available (check your local library for information), but its low-end technology provides text only, so it is not recommended for someone who wants a friendly graphical environment.

Mega-Websites . . .to Take You Almost Everywhere You Want to Go

One of the easiest ways to access educational materials on the Web is to use one of the Mega-Websites especially designed to link people to key educational sites. Several such sites are described below.

AskERIC
<http://ericir.syr.edu>

→ AskERIC

ERIC (Educational Resources Information Center) is the national educational information system sponsored by the U.S. Department of Education. AskERIC is an awesome link to those resources. The Homepage lists six topics from which to choose: About AskERIC, Question & Answer Service, Virtual Library, New and Noteworthy, Research & Development, and ERIC Database Searches.

If you select the AskERIC Virtual Library, you will get ten more choices:

- ***AskERIC Toolbox***—Provides links (*gateways*) to educational sites, Internet project resources, cool sites for kids, and Internet search tools and training resources.

Want to see the Homepage for the CIA, Library of Congress, National Science Foundation, NASA Spacelink, Smithsonian, or PBS? Simply click on the entry. Many of the sites suggested in the next section by net users, are listed here—one-stop shopping. If you want a site that's not listed, search engines for looking further are also provided. If you're having trouble using the Internet, you'll find three Internet training sites here to help you.

- ***AskERIC Infoguides***—Provides access to an extensive list of Infoguides on such subjects as chemistry resources, earthquakes, earth science, the environment, weather, grammar instruction, teaching Shakespeare, education software, freeware, Internet resources, and portfolio assessment.
- ***AskERIC Lesson Plans***—Links users to lesson plans submitted to the ERIC database and highlights new plans each month. Also provides a link to the NASA SIR-C Education Program (SIR-CED).
- ***Special Projects***—AskERIC works with several organizations, supporting their efforts in providing education information over the Internet. Current special projects include the Consortium for School Networking (CoSN), Cross A K-16 American History Curriculum, Newton's Apple Educational Materials, Chinese Historical and Cultural Project (lesson plans), and SIR-CED.
- ***Education Listserv Archive***—Pick a mailing list of interest to you from this listing (e.g., VOCNET) and you will find a list of articles posted to the group, arranged by year, then month.
- ***ERIC Resources***—Allows you to search the ERIC database and the materials developed by ERIC staff (digests, bibliographies, etc.).
- ***ERIC Conference Calendar***—Lists education-related conferences available each month. Information provided includes conference site, sponsor, date, location, topics, and intended audience.
- ***Television Series Companion Materials***—Provides access to educational resources (including lesson plans) produced by various networks (PBS, CNN, C-SPAN, ABC, CBS, Discovery Channel), some of which are designed to be used in conjunction with their programming.

- ***More Educational Resources***—Links to organizational resources such as the U.S. Department of Education, National Library of Education, Regional Educational Laboratories, Vocational Education Resources, National Service Learning Clearinghouse, and Instructional Technology Resources.
- ***Professional and Commercial Announcements***—Provided as a service to AskERIC users, these announcements carry no intention of endorsement.

Project Appleseed Website
<http://members.aol.com/pledgenow/appleseed>

→ Project Appleseed Website

The Website for Project Appleseed, the National Campaign for Public School Improvement, provides gateways to 20 of the Internet's most respected and widely visited educational organizations and news sources in America.

Vocational Education Resources
<http://pegasus.cc.ucf.edu/~sorg/vocation.html>

→ Vocational Education Resources

Provides gateways to more than 60 sources for general information about vocational education, curriculum resources for vocational education, school to work/tech prep, research in vocational education, federal government information on vocational education, legislation on vocational education, publications for vocational education, higher education and public school resources within vocational education, international interests in vocational education, career and job information in vocational education, and training in vocational education.

NOICC Homepage
<http://www.state.ia.us/government/wd/noicc>

→ NOICC Homepage

The Homepage of the National Occupational Information Coordinating Committee provides access to a wide range of workforce and career development information and resources, including job search sites, career information, career development guidance and counseling, labor market information and education sites, SOICC (state-level) sites, a calendar of events, and NOICC/SOICC initiatives, resources, and activities.

Educational Websites Recommended by Net Users

Here's just a sampling of recent "mail" on the Internet about specific Websites of potential interest to teachers of vocational education and applied academics. In some cases, information is also provided about what this author found when she checked out the site.

→ From Todd Digby <digbyt@Access.TKM.MB.CA>
Searchmaster, TKM Software Ltd.

I am glad to announce the official launch of TKM's Education Web Search, a new, free educational search engine. Each site has an abstract and is rated. Each weekday, a new five-checkmark site of the day is picked.

Education Web Search: <http://www.tkm.mb.ca/education>

→ From Patricia Carnabuci <pmc@aloha.net>
Webmaster, Education World

Education World offers education professionals a free, top-quality education search engine. Each of the 20,000+ sites is described and rated.

Education World: <http://www.education-world.com>

One of the sites reviewed was the Internet Resource Directory for Educators, basically a page of links to other resource areas, most of which link to still other resources.

Internet Resource Directory for Educators: <http://www.tapr.org/~ird>

Another reviewed site, The Teachers Network, is designed primarily to help teachers use the Internet to share ideas and get information on available grants and projects.

The Teachers Network: <http://www.teachnet.org>

→ From David van Popering <dutch@lilrc.org>
South Country Library (Bellport, Long Island)

Great new Webpage with something for everyone: teachers, librarians, kids, adults. Your one-stop Webpage. The page includes search engines, reference items, book review sites, good download sites, and science.

Website: <http://www.lilrc.org/~sctylib>

➜ From the VOCNET moderator
Federal School-to-Work Homepage:
<http://www.stw.ed.gov>

When you access this page, you can choose from an extensive list of topics, including a chat room and extensive links to other relevant Internet sites in the following categories: all youth, occupational information, education, employers, government, education and the workforce, and skill standards.

➜ From Bill Kelly <kelly@teachers.net>

Teacher's Net has just released a new resource designed to help teachers discover creative and dynamic ways to teach tired subjects: the Teachers.Net Lesson Plan Exchange. Teachers with plans they wish to share complete a short form, including a bit of information about themselves, and then submit either the complete lesson plan or just the URL where others can locate the plan. Teachers wanting access to a particular plan can post a request on the Exchange Board.

Teachers.Net: <www.teachers.net>

Lesson Plan Exchange: <http://teachers.net/lessons>

Other free resources are available as well to help teachers easily integrate web technologies into their teaching curriculum:

Homepage Generator: <http://teachers.net/sampler>
Website Handbook: <http://teachers.net/manual>
WebTalk Mailing List: <http://teachers.net/webtalk>

➜ From Sharon Woodcock <woodcock@fiu.edu>
School-to-Work Evaluation Program Coordinator

Florida STW Clearinghouse: http://fcn.state.fl.us/flstw

At this Homepage, you will find a navigator providing access to the following topics: evaluation, legislation, organizations and contacts, other networks, professional development, publications, public relations, upcoming events, what's new, and work/labor employment. The Other Networks section includes four pages of links to state and national education sites, including the VOCNET Listserv and two sites for applied academics: Electronic School, Southwest Center for Advanced Technological Education.

→ From Nicholas Moran <NLM@aol.com>
Chair, Department of English
Worcester (MA) Vocational High School

Worcester Vocational High School's Homepage is a hands-on project of the Applied Communications classes. Students maintain the page and add submissions to the Applied Academics Project, a resource for Tech Prep applied learning teachers looking for ideas. Any vocational or academic instructor can submit a page and will be credited for the submission.

Send comments and ideas to <nim@mass.ultranet.com>

Website: <http://www.ci.worcester.ma.us/schools/schools/voke/index.html>

→ From Carl Wozniak <cwozniak@nmu.edu>
Projects Coordinator

Please visit the Glenn T. Seaborg Center for Teaching and Learning Science and Mathematics.

Website: <http://seaborg.nmu.edu>

→ From Teresa Costanzo
<idontknow@chroma.mbt.washington.edu>
Department of Molecular Biotechnology
University of Washington

"I Don't Know—Let's Do the Experiment: Microscopes, Cells, DNA, and You" is an innovative adult-level science course taught with the same style, pedagogy, and techniques recommended for science teaching at the elementary school level. Adults interested in science and science learning should find the course content and materials interesting, fun, and mind-expanding. The course was funded by the National Science Foundation and produced by a collaboration of Seattle teachers, the University of Washington College of Education, and molecular biotechnologists. The Website includes the course curriculum, philosophy, and methodology, including entire lesson plans, materials, book lists, and resources. It also provides links to other science education sites.

Website: <http://chroma.mbt.washington.edu/outreach/hands_on_science.html>

→ From Brent Coles <nef@xmission.com>

With the support of various natural gas utilities, the NEF Academy for Natural Gas, a division of the National Energy Foundation, is pleased to provide free educational materials related to natural gas and other energy and environmental topics. These materials are available to current K-12 classroom teachers at recognized public and private schools only. Supply is limited (posted 10/31/96). To order your free packet, access the National Energy Foundation Homepage.

Website: <http://www.xmission.com/~nef>

→ From Education World <http://www.education-world.com>

EarthWatch Global Classroom is the Website for EarthWatch, a nonprofit organization that combines both citizens and scientists in projects to maintain the Earth's ecosystem. The page has sections on student awards, field research opportunities, fellowships/internships, and school partnerships. The section on the worldwide network of scientists is easily accessible and provides links to scientists broken out by their specialty. An excellent feature is the Ask the Scientist page where questions from students are posted and answered by a scientist specializing in that particular field.

EarthWatch Global Classroom:
<http://www.earthwatch.org/ed/home.html>

→ From Alan R. Fisher <Alan_Fisher@mail.fws.gov>
Acting Chief, Branch of Standards, Policy & Planning Division
Division of Information Resources Management
U.S. Fish and Wildlife Service

I am pleased to announce that the U.S. Fish and Wildlife Service has launched another World Wide Web server to support our goal of sharing our data and information.

Website: <http://www.fws.gov/~r9ohr>

→ From <tubie@math.harvard.edu>

For a kid who is good at mathematics and is looking for something more challenging, try the following site, which has a lot of sets of problems:

Website: <http://www.actden.com>

For a kid who is less competitive, the following site has more dynamic and personalized programs and random fun (and educational) links, discussion room, design-your-homepage, and more:

Website: <http://www.gomath.com>

→ From Don Specht <dspecht@ix.netcom.com>

Ask Dr. Math is part of a site devoted to mathematics, the Math Forum.

Math Forum: <http://www.forum.swarthmore.edu>

Dr. Math: <http://www.forum.swarthmore.edu/dr.math/dr-math.html

Additional References

For more information about the Internet, consider consulting some of the following sources:

Morris, Evan. *The Book Lover's Guide to the Internet.* New York, NY: Fawcett Columbine, 1996.

Contains chapters on what the Internet is and where it came from, simple ways to connect yourself to the Internet, the many paths through the Internet, adding your two cents' worth, participating in mailing lists, publishing online, online resources for book lovers, and staying abreast of new resources on the Internet.

Sagalyn, Raphael et al. *The Great American Web Book: A Citizen's Guide to the Treasures of the U.S. Government on the World Wide Web.* New York, NY: Random House, 1996.

According to the cover of this book, "with the click of the mouse, you can retrieve new data from the Census Bureau; get the latest health findings from the Centers for Disease Control; browse priceless Smithsonian Museum collections; dissect a 'virtual frog' at the Energy Department; e-mail your senator on pending legislation; explore the solar system courtesy of NASA; access K-12 study guides at the Education Department; enter the halls of the Library of Congress; and so much more."

The following resources are available to Ohio teachers for two-week loan from the Tech Prep Collection at the Center on Education and Training for Employment, 1900 Kenny Road, Columbus. Contact Steve Chambers, librarian, by e-mail <chambers.2@osu.edu> or by phone: 614-292-4353 or 800-848-4815, ext. 4-7642.

Cotton, Eileen Giuffré. *The Online Classroom: Teaching with the Internet.* Bloomington, IN: EDINFO Press, 1996. (TP 001 038)

Contains information on the Internet in general (what it is, how to use it); e-pals and keypals; using Netscape; locating teaching resources; how to use Gophers; books available online; telenetting; searching; how to read an ftp address; building your own Webpage; and more.

Essex, Christopher, comp. *The Internet and the K-12 Classroom.* Bloomington, IN: EDINFO Press, 1995. (TP 001 039)

Designed to be used individually or in a workshop setting, this document is a compilation of ERIC documents relating to Internet use in education. A bibliography of additional resources is also provided.

The following resources are available from Vocational Marketing Services; Phone: 800-343-6430

Internet for Teachers

Written by teachers for teachers and produced by the company responsible for the For Dummies series, this book provides a fun and easy way to explore and download materials from the Internet. A troubleshooting section is also provided.

Internet Roadside Attractions

Seven experienced Internauts share their favorite Websites, Gophers, ftp sites, chats, games, newsgroups, and mailing lists. Includes a 500-page softcover book and a CD-ROM version with the entire text of the book.

The Internet Tour Guide: Cruising the Internet the Easy Way, 2nd ed.

This book/disk combination gives step-by-step instructions to guide users through each process, supported by scores of illustrations. Includes information on what's available through the Net, how to get connected, and how to navigate its vast information resources. The disk contains helpful utilities that aid in processing e-mail, navigation, and file compression. Available in Macintosh and Windows versions.

Curricular Resources for Applied Academics

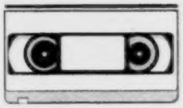
Curricular Resources for Applied Academics

Clearly, there are hazards inherent in any resource list. For one thing, no sooner is it developed than it is out of date. Moreover, publications go out of print, may be expensive, or may be hard to find. So, here are some suggestions for using the following resource list wisely.

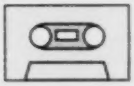
- *Be on the lookout for new materials.* The resources that follow should be taken as examples of the types of materials that are out there. By contacting the publishers listed—publishers who seem committed to supporting integrated, applied, hands-on instruction—you can easily get an up-to-date catalog of available materials. Information for contacting these publishers via phone, fax, e-mail, or Internet is provided at the end of this section.
- *Don't ignore older material.* Just because particular materials are no longer available from a publisher doesn't mean they no longer exist. If you are trying to develop integrated curricula for your program, it can be very useful to have access to a variety of resources, whether they are still for sale or not. Check your school, district, college/university, city, or state libraries for sources of interest on this list.

  You will note that some materials carry a TP #. These are materials that are part of Ohio's Tech Prep Library located at the Center on Education and Training for Employment, 1900 Kenny Road, Columbus. The collection contains over 1,700 items at present, each of which was selected based on reviews by academic and vocational teachers, counselors, and administrators in Tech Prep programs. These materials are available to Ohio educators on a two-week free loan basis.
- *Use the CETE library.* Better still, visit the collection at the CETE library so you can browse. The texts listed in this section focus on applied academics, but the collection also contains a wealth of technical texts. If you are an applied academics teacher wanting to learn more about the occupational areas of your students, there are many excellent texts here that could be of help. What's more, if you are an applied science teacher, the ERIC Clearinghouse for Science, Mathematics, and Environmental Education is right across the street.

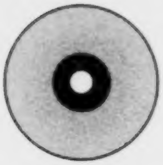
- *Utilize major and minor publishers.* The focus of the listing is on sources other than major publishers (although some major publishers are represented). The reasons are several. One is that major publishers do a good job all by themselves of promoting their products in the schools. A second is that the names of and contact information for major publishers tends to be a slippery issue these days. They merge a lot. One day you have Addison Wesley and Longman, the next you have Addison Wesley Longman. If you have access to the World Wide Web, use of a search engine will quickly locate major publishers for you, referring you to a publisher's new name and web address if there's been a change. Many major publishers have catalogs online or a button you can click to have a print catalog sent to you.
- *Watch for icons signalling media other than texts.* The listing includes videos, audiocassettes, read-only compact discs (CD-ROM) and software. These are represented by the following icons:



Videos



Audiocassettes



Compact discs

Software

Please Note: In most cases, the annotations have been drawn from descriptions provided by the developers or publishers, and no endorsement of the products is intended.

Resource Catalogs

Association for Supervision and Curriculum Development (ASCD)

✓ *Brown's Directory of Instructional Programs: Language Arts* TP 000 575

✓ *Brown's Directory of Instructional Programs: Math* TP 000 578

✓ *Brown's Directory of Instructional Programs: Science/Health* TP 000 579

These directories are comprehensive references for nearly all commercially published teaching materials and programs, including basal, supplementary, and software programs. As you search through the sources listed, look for terms such as ***hands-on activities, everyday or real-world applications, situational lessons, practical problems, inquiry and problem-solving approach, etc.***

✓ *Curriculum Materials Directory: Noncommercial* TP 000 581

This ASCD directory includes the curriculum materials and programs developed by schools, district offices, and education agencies worldwide.

Applied Communications, Mathematics, and Science

Career Communications, Inc.

✓ *American Careers*

This **magazine**, produced three times a year, provides content of high interest to vocational students, and its articles lend themselves to use in applied academics classes. In fact, applied math, science, and communications are a focus of the magazine's writers.

For example, students can use the article "Are There Any Good Manufacturing Jobs Left?" as a basis for oral discussion in a communications class. They can use a table on the "Top Metro Areas for Average Pay" as a basis for library research on cost-of-living figures and quality-of-life statistics for the cities listed. They can learn about a communication skill not written about in most school texts: schmoozing.

A table presenting data on 50 fast-growing careers, average salary per year for each, and training needed after high school could be the basis for a variety of math activities. An article on the plastics industry includes math problems you would have to be able to answer to be a moldmaker apprentice (e.g., If the spindle of a micrometer advances .025" for each revolution, what is the number of threads per inch of the screw?). Want students to appreciate the role geometry plays in the world of work? How about an article on unusual careers for people who love shapes—one in which a LEGO® block model builder says, "Just try building a motorcycle wheel or a sphere out of a little square block, and you'll see where the math comes in handy."

Math and science skills needed in the real world are covered in such articles as "Creative Careers That Demand Math and Science Skills," "Calculate the Value of Math and Science Careers," and "What Do Math and Science Have to Do with Life Anyway?"

Curriculum Materials Service—Ohio

✓ *Teaching for Connection: Critical Thinking Skills, Problem Solving, and Academic and Occupational Competencies*

This is an excellent source for vocational teachers wishing to integrate academic competencies and activities requiring critical thinking and problem solving into their lessons. The text begins with a 20-page introduction explaining the text's philosophy, detailing the steps in the lesson development process, and providing a sample lesson plan format. The bulk of the publication, then, comprises sample **lesson plans** from a variety of vocational service areas.

EDINFO Press

TP 001 043

✓ *Reading and Writing across the High School Science and Math Curriculum*

To counteract the breakdown between scientific thinking and the intelligent use of language, the author compiled a collection of **lesson plans** drawn from tried and tested material in the ERIC database. These lessons help you build good language usage into your already existing science and math curriculum. The plans are grouped into the following topics: writing science, reading science, wording science, short scientific writing assignments, long scientific writing assignments, science and imagination, and analogical reasoning—from science and math to world and ideas, and back again. Math is incorporated within these "science" topics.

- ✓ *Writing across the Curriculum Leader's Manual*
  This workshop manual presents a writing program designed to be incorporated in all content areas without disrupting teachers' established syllabi or adding significantly to teachers' already heavy schedules and workloads. Leader notes (including discussions of the pertinent literature and answers to the most commonly asked questions), group discussion, activities, and overhead transparencies are arranged sequentially for a step-by-step, page-by-page presentation. The manual is loaded with activities for content-area teachers to try out in the workshop setting. It is recommended that the workshop participants supplement this material with the book *Writing Is Learning* by Howard Willis.

TP 001 044

Virginia Vocational Curriculum and Resource Center

- ✓ *Collaborative Lesson Plans*
  Developed by Virginia teachers, this collection of **lesson plans** provides innovative, challenging ideas for integrating academic (math, science, English, and history/social studies) and vocational disciplines.

Applied Communications

Agency for Instructional Technology (AIT)

✓ *Applied Communication*

Samples TP 000 795-796

Materials in this **package** include instructor's kit, instructor's guide, worktext, and videocassette. The two sample modules in the Tech Prep collection focus on technical writing and electronic communication. The total set includes 17 modules.

American Tech

✓ *Building Trades Dictionary, 2nd ed.*

The first part of this dictionary presents terms related to the building trades in a clear, heavily illustrated style. Separate sections define legal terms often used in the construction industry and contractor's terms (related to estimating, bidding, etc.). An extensive appendix provides common conversion tables, geometric figures, print symbols, and professional organizations.

Cambridge Educational

✓ *Constructive Communications: Talking Your Way to Success*

This 30-minute video uses entertaining vignettes to demonstrate a process for effective communication, including how to identify the effect you hope to achieve, understand the knowledge and attitude of the audience, explain your subject with specific and organized information, and see the positive effects of knowing and understanding yourself.

✓ *Effective Listening Skills: Listening to What You Hear*

Listening, which may be the most essential communication skill of all, is the focus of this 30-minute video. Students learn the benefits of listening and master the skills by deciding to listen, reading all stimuli, investing spare time wisely, verifying what they hear, and expending energy.

✓ *School to Work: Communication Connections for the Real World*

In this video series, experts share their day-to-day wisdom and relate directly to the need to connect the academic communication skills with the work arena. Each 20-minute tape begins by stressing why communication skills are important to a given work area (e.g., electronics, automotive repair, construction, production technology). Specific communication skills are then highlighted, with numerous on-screen examples modeled for students. Includes **reproducible worksheets**.

✓ *Shop Talk*

The words and definitions in these software packages have been compiled to make it easy and fun to teach course-related vocabulary. In minutes, *Shop Talk* automatically creates 7-10 different types of worksheets: word search, word scramble, word order, word match, word completion, etc. In addition, you can change any words and definitions, add words and definitions, or create entirely new disks with your own words and definitions. Programs available include arc welding, auto body, auto mechanic, framing, job words, masonry, plumbing, sheet metal, small engines, wiring, housing, manufacturing, robotics, and tech ed.

✓ *Think Tank: Applied Communication*

With the Think Tank print units, students use their applied communication skills to solve problems they might actually encounter in a real job situation. Each print unit consists of a series of **individual job simulation activities**, teacher's guide, and answer sheets. The key critical thinking skills used to solve the problems found in each activity are also identified.

✓ *Vocational Writing Skills Pack*

A host of **job-oriented writing activities**, as well as a pre/post-test, are provided in each occupation-specific pack. Packs are available for 13 areas, including construction, metals/welding, industrial tech, auto mechanics, and others.

✓ *Writing for Results: The Winning Written Report* 📼

The importance of good writing skills to job entry and job success is stressed in this 30-minute video. The process presented shows how to analyze your prospective reader; determine the report's purpose; select and narrow the topic; gather, record, and file information; organize the paper; provide concrete and specific supporting material; proofread and revise; and prepare the final product.

Contemporary Books

✓ *Essential Skills for the Workplace (Level One): Obtaining Information and Using Resources* TP 000 628

Text covers telephone messages, reference materials, policy manuals, charts and tables, product information for selling, product information for purchasing, mileage charts and transportation schedules, shipping and receiving documents, and measurements (e.g., of size and space, weight, pressure, temperature, time, and money).

✓ *Essential Skills for the Workplace (Level One): Using Forms and Documents* TP 000 627

Text covers personal forms, paychecks, credit, application and training forms, certification and licensing forms, starting a job, time sheets, benefits on the job, order forms, billing forms, contracts and agreements, warranties, and legal notices.

✓ *Expressions: Stories and Poems* TP 000 618

This collection of 20 unabridged stories and poems showcases a wide range of writing styles for student interpretation.

✓ *Viewpoints: Nonfiction Selections* TP 000 619

Contains over 20 short pieces of nonfiction (both excerpts and full length) that focus on timely themes such as family relationships, humor, personal freedom, employment, and war.

TP 000 623-624

✓ *Communication Skills That Work: A Functional Approach for Life and Work*
Book One covers giving and following directions; gathering information; stating a viewpoint; writing labels, lists, and notes; and filling out charts and forms. Book Two covers listening and speaking effectively, asking questions and giving directions, interviewing techniques, and writing memos and business correspondence.

TP 000 621-622

✓ *Reading Skills That Work: A Functional Approach for Life and Work*
Book One covers building vocabulary, interpreting graphics, following directions and procedures, skimming and scanning for information, and developing reference skills. Book Two covers interpreting and summarizing written materials, evaluating information and drawing conclusions, classifying and prioritizing information, researching a task, and working and problem solving as a team.

Curriculum and Instructional Materials Center—Oklahoma

CIMC's English series was designed to reinforce basic skills concepts through practical exercises and practice. Emphasis is placed on functional literacy. Titles include the following:

✓ *English: Volume II*
Contents provide related vocational information, employability skills, personal development, writing skills, parts of speech, library skills, practical usage, and life skills. Text is supported by **36 transparency masters**, **3 job sheets**, and **144 assignment sheets**.

✓ *Parts of Speech*
Text covers nouns, pronouns, conjunctions and interjections, prepositions, adjectives, and adverbs.

✓ *Introduction to Writing*
Contents focus primarily on the writing of sentences. Text is supported by **24 assignment sheets**.

Delmar Publishers

- ✓ *Illustrated Dictionary for Electrical Workers*
  Dictionary contains 1,000 words, terms, and phrases peculiar to the electrical trades.

Glencoe/McGraw-Hill

- ✓ *Gregg Reference Manual*
  Although the publishers insist on listing this text only in their Business Reference Texts—rather than English Texts—section, it is in fact the single best reference for grammar, style, and usage questions that this writer/editor/former English teacher has ever encountered. This is the handbook that is always at my fingertips. The explanations of the "rules" are simple and clear, each supported with very helpful samples of right and wrong. The index is extensive, allowing you to find the rule you want. Contents cover punctuation; capitalization; numbers; abbreviations; plurals and possessives; spelling; compound words; word division; grammar; usage; editing, proofreading, and filing; letters and memos; reports and manuscripts; notes and bibliographies; tables; other business documents; and forms of address. Glossaries present grammatical terms and computer terms. Two **supplementary volumes of worksheets** are available to provide students with practice in applying the rules.
- ✓ *Writer's Choice: Composition and Grammar Series (9-12)*
  The communication skills of writing, speaking, listening, and thinking are integrated in this text. Case studies that show how writers handle real-life writing projects are provided to give students a chance to role-play, think critically, and write. Each composition lesson ends with a full page of guided, cross-curricular, and open assignments, allowing for varying levels of self-direction. Each grammar, usage, and mechanics unit ends with a Workshop feature, which reinforces the relationship between these topics and the worlds of writing and literature. Literature selections in each composition unit reflect the quality and diversity of professional writing today.

Goodheart-Wilcox

✓ *Successful Technical Writing*
Proper procedures for producing effective business documents are the focus of this text. Memos, various types of reports, letters, operation manuals, owner's manuals, executive abstracts, and proposals are among the topics covered.

Great Source, Houghton Mifflin

TP 000 412

✓ *Writer's INC: A Student Handbook for Writing & Learning*
A stunning paperback book (in this writer's opinion) that supports integration at a variety of levels. Instead of separate grammar, literature, speech, and composition texts, this book blends it all under one cover, producing a true ***handbook*** for students as they work on their communication skills across subjects. The major sections address the writing process, basic elements of writing, searching and researching, forms of writing, writing about literature, reading and study skills, and speaking and thinking.

These are further supported by a **proofreader's guide** to grammar and style and an **almanac** with full-color maps, traffic signs, periodic table of elements, U.S. Constitution, parliamentary procedures, multiplication and division tables, weights and measures, metric system, planets, U.S. Presidents and Vice Presidents, and historical time line.

There are no traditional assignments or exercises. Instead, this is a "portable" guide to students' own writing and learning. The instruction is supported with lots of actual good and bad examples of writing—some from well-known authors, some from published works by student writers. A teacher's guide is available to support use of the text.

✓ *Writer's INC. School to Work: A Student Handbook*
This is very much like the handbook described previously, with the same rigor, but the writing samples focus more on workplace writing and speaking and less on creative writing. Major topics include the communication process; the writing process; basic elements of writing; forms of writing; writing in the workplace; research writing; searching for information; speaking and listening; issues in the workplace; and reading, thinking, learning.

✓ *Daily Language Workouts*
This flexible teacher's resource includes **high-interest language activities** designed to help students develop their editing and proofreading skills. The activities are short and fun, take only a few minutes of class time, yet pack a lot of punch. They can be used for oral or written practice to pump students up for effective communication. Activities include daily MUG Shots (sentences containing language blunders in ***m***echanics, ***u***sage, and ***g***rammar for students to identify and fix); weekly MUG Shot Paragraphs to edit; daily writing practice activities in which writing prompts (photo, quote, graphic) inspire free writing on a variety of topics; sentences for modeling and expanding penned by well-known writers; and show-me sentences, which give students starting points for writing strong, active sentences.

✓ *Writer's Express: A Handbook for Young Writers, Thinkers & Learners*
This text covers everything from the writing process to historical documents, from study skills to writing riddles, from speaking and listening to solving word problems. Although designed for the middle-school level, these materials could be used for students who need more-extensive remediation.

TP 000 476-479

✓ *Writer's Files: Grades 9-12*

The Writer's File for each level provides a sequence of **reproducible writing and language activities** that can serve as the focus of a new and stimulating writing program when used in conjunction with *Writer's INC* or as a supplement in an existing program. Provided for each level are 18 "sequential" writing activities; 50 or 60 writing workshops; over 200 daily language activities; and numerous reproducible forms, strategies, and resources.

Lakeshore Learning Materials

Lakeshore Basics & Beyond materials are designed for students who are hard to reach, at risk of dropping out, or in need of a fresh approach to learning. If you have students in need of remediation or if you have students who could benefit initially from materials written at a lower (or controlled) reading level with a high interest level, Lakeshore may be a good source for you. Some examples of **videos**, **worktexts**, **texts**, and **game/activity books** that could be of interest follow.

✓ *201 Ready-to-Use Word Games for the English Classroom*
✓ *Better Writing for Better Jobs Worktext*
✓ *English Ideas That Really Work*
✓ *English Teacher's Book of Instant Word Games*
✓ *How to Write Sentences Video Program*
✓ *A Picture Is Worth 1,000 Words: Story Starters*
✓ *Real-Life Communication at Work*
✓ *Standard English Video Activity Program*
✓ *Take the Fear Out of Shakespeare*

Facing pages present Shakespeare in the original version and in modern translation. The ten plays in this series are available as a set or individually.

Paradigm Marketing Group, Inc.

✓ *Applied and Integrated Academics*

An outline software series of three IBM disks designed for use as a supplement for any applied communications curriculum or text (e.g., Applied Communications, AIT; Communications 2000, South-Western Publishing). Includes *Survey*, a stand-alone program that students can use to design and record survey data; *EMS*, a stand-alone personality program (a simple, yet accurate, Myers/Briggs-type test); an **integration handbook**; and a **school-to-work handbook**.

✓ *Telephone Techniques: Building Communication Skills*

TP 000 739-745

This set of six audiocassettes is supported by an accompanying study guide.

Procter & Gamble Educational Services

✓ *Public Relations Guide*

Although written to help teachers and others to use public relations techniques on behalf of their organizations and programs, this guide (available free of charge and reproducible without permission) could easily be used with students in lessons focusing on communication through promotion and advertising. It provides basic information about the role, purpose, and functions of public relations so that readers will be able to develop and implement their own public relations plans. **Samples**, a **glossary** of terms, and lists of **public relations resources** and additional sources of information support the text.

✓ *Advertising and the Economy*

This 32-page classroom teaching guide includes a profile of advertising's history and its role in the economy, eight **reproducible lessons** on advertising and the economy, **teaching tips** for each lesson, a full-color **poster** depicting advertising's evolution, and a **video guide**. Although focused on economics, the materials could easily be adapted for use in communications classrooms where the focus would be on writing to sell and recognizing the propaganda techniques used in advertising.

- ✓ *American Literature for Life and Work*
- ✓ *British Literature for Life and Work*

  These anthologies group the literature offerings into high-interest, relevant topics (e.g., community and responsibility, innocence and experience, choices and possibilities). Each grouping is followed by assignments requiring students to explore, understand, and connect. Students are invited to express their own views, share them with others, work on teams, and make a significant difference in the community. The lessons emphasize practical writing for the real world—meeting the high standards of business, working collaboratively. Workshops at the end of the text give students practice in moving from school assignments to workplace tasks.

- ✓ *Communicating for Success: An Applied Approach*

  Three of the authors of this text hail from Ohio's Great Oaks Institute of Technology and Career Education. Lessons are not structured around traditional topics such as nouns, verbs, etc. Instead grammar, punctuation, and usage are addressed when they are important to a specific job-related task. In every chapter, students have a chance to practice language skills tied to the tasks in which they are used in business and industry. Each chapter is arranged as follows: introduction, warm-up exercise, practice, and project. Once a skill has been introduced, it is not forgotten; its use is woven throughout subsequent chapters. Chapter topics include communicating at work, communicating definitions, listening and responding, giving instructions, describing a process, describing a mechanism, summarizing, completing forms, communicating messages (memos, letters, and notes), persuading, applying for a job, comparing and contrasting, interviewing for information, using numbers and statistics, presenting reports, and becoming a professional.

- ✓ *English: Critical Thinking and Writing*
  Developed with the National Council of Teachers of English, this guide is designed to help students improve their writing and critical thinking skills using activities with a real-life context through the pages of *USA TODAY*

Although the next two sources aren't "applied communications" per se, they would be a rich resource for providing content that vocational students could use as the basis for assignments involving reading, writing, speaking, and/or discussion.

- ✓ *Business Today*
  Developed in cooperation with Future Business Leaders of America, this guide supports the use of *USA TODAY* as a real-world text in learning key business concepts from the national and international business world.
- ✓ *Careers: A Lifetime Journey*
  Developed in cooperation with the National Career Development Association and the Department of Labor, this career education program provides educators with real-world tools and information to assist students in lifelong career planning. Leads students through self-assessment activities and introduces them to role models.
- ✓ *Today's Issues*
  Developed in cooperation with the National Education Association, the activities in this program use *USA TODAY* to address the critical issues facing today's teens and to reinforce critical thinking, decision making, cause-and-effect analysis, and goal planning.

Applied Mathematics and Science

Curriculum Publications Clearinghouse— Illinois

✓ *Phys-Ma-Tech*

To encourage students who do not traditionally enroll in physics to do so, these **activity-based materials** integrate the academic content of three disciplines—physics, math, and technology—and relate it to real-world experiences. The materials—which are designed to improve high school physics without diminishing the content or rigor of the subject—expose students to a variety of technological devices, systems, and processes. The activities have been tested and can be used, adapted, or expanded for use in a variety of teaching contexts. A videotape is available to support the print materials.

Glencoe/McGraw-Hill

✓ *Technology: Science and Math in Action*

Two Student Activity Texts, each containing five modules, present **hands-on activities** in which students use scientific and mathematical concepts to solve technological problems. Students do experiments, complete activity sheets, and design and build products. Career information and the history of technology are included. Topics include hydroponics, bridges, printed images, rockets, electricity, recycling, and videos.

✓ *Technology, Science, and Mathematics Connections Activities: A Teacher's Resource Binder*

Each activity in this Teacher's Resource Binder provides a technological problem to be solved and describes the technology, science, and mathematics applications students will use. The technology component provides guidance for designing, constructing, and evaluating a product. The science and mathematics components are related to the product and to **real-world problems and situations**. Math topics are correlated to NCTM standards. Topics include pollution-free vehicles, power boat, robotic transfer, and rocket payload.

Applied Mathematics

American Tech

✓ *Practical Math*

Designed for use in a refresher course or as a handy reference, this text stresses the practical aspects of math. It covers number theory, decimals, fractions, roots and powers, measurement, basic operation, and formulas. Problems included are oriented to trade and industrial calculations.

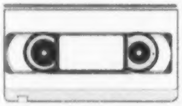
✓ *Related Mathematics for Carpenters, 2nd ed.*

In this text, basic math is applied to practical carpentry. It includes examples and problems for developing the math skills needed for this trade.

✓ *Technical Reference Handbook*

Two of the sections in this handbook for the industrial-technical trades focus on mathematics and units of measurement. Practical skills for solving mathematical problems are presented in simple, clear, straightforward language. Essential formulas are presented in an easy-to-use format.

Bergwall Productions, Inc.



Bergwall's instructional video programs are designed to correlate with existing applied math curricula, such as the one developed by the Center for Occupational Research and Development (CORD). Sample titles include the following:

✓ *Basic Math for Auto Technicians*
✓ *Basic Math for Electronics*
✓ *Conversion of Fractions, Decimals, and Percentages*
✓ *Decimal Numbers*
✓ *Flow Charts*
✓ *Fractions and Decimals*
✓ *Material and Cost Estimation*
✓ *Measuring with Bore Gauges*
✓ *Measuring Tools*
✓ *Measuring Voltage*
✓ *The Metric Ruler*

✓ *Multiplication and Division*
✓ *The Outside Micrometer*
✓ *Percentages, Ratios, and Rates*
✓ *Practical Geometry*
✓ *Precision Measuring Tools*
✓ *Reading a Ruler*
✓ *Service Manual and Wiring Diagrams*
✓ *Shop Math*
✓ *Size and Location Dimensions*
✓ *Statistical Process Control*
✓ *Trigonometry*
✓ *Trouble Codes*
✓ *Using Dial Indicators*
✓ *Using the Vernier Calculator*
✓ *Working with Depth Gauges*
✓ *Working with Ohm's Law*

Cambridge Educational

✓ *Applied Math*

This software program is designed to enhance the nationally approved Applied Math curriculum developed by the Center for Occupational Research and Development (CORD). Each unit contains one computerized lesson and quiz, written handout quizzes, teacher helps, and computerized quizzes related to specific careers, including those in industrial technology. Units—which may be purchased separately, in clusters, or as a total series—cover introduction to the calculator, problem-solving techniques, estimating answers, English and metric measurement, working with graphs and tables, using data, working with straight lines and angles, working with 2-D shapes, working with 3-D shapes, ratio and proportion, using scale drawings, signed numbers and vectors, scientific notation, precision accuracy and tolerance, problems involving powers and roots, using formulas, solving linear equations, using graphical data, nonlinear equations, using statistics, working with probabilities, right triangle relationship, trigonometric functions, factoring, relationships and functions, quadratic equations, systems of equations, inequalities, applied geometry 1 and 2, working with computer spreadsheets, working with computer graphics, and quality control 1 and 2.

✓ *Applied Mathematics Program (AMP)*

The diagnostic/prescriptive AMP software (IBM, Macintosh, Apple) provides vocational and academic instructors with a means of assessing, instructing, and testing math skills directly applied to specific occupational training programs, including electro-mech tech, industrial tech, auto mechanics, construction, electronics, metals/welding, and auto body.

✓ *Basic Math Skills for the Real World*

This menu-driven IBM software program assesses and improves basic math skills while stressing their importance in the job market. In the first part, students work at a variety of jobs where they are challenged with typical job tasks involving basic math skills. As they perform the skills, their ability levels are assessed and they receive suggestions for areas needing improvement. The second part of the program shows how math skills are used daily in over 20 jobs. In the final part, games challenge students to solve problems in order to save the world, escape a maze, or travel through time.

✓ *Math for Principles of Technology*

The 14 software units in this series are designed for use in programs using Principles of Technology, the applied physics course designed by the CORD/AIT. The units provide an alternative teaching tool (e.g., for students who need to make up work or who need to spend more time mastering a concept), as well as an evaluation tool. Units provide math lessons and quizzes relating to the following concepts and principles: force, work, rate, resistance, energy, power, simple machines, momentum, waves and vibrations, energy converters, transducers, radiation, light and optical systems, and time constants. Available for IBM and Macintosh.

✓ *Math with Micrometers*

The purpose of this software program (IBM, Macintosh, Apple) is to help students learn how to use the micrometer, how to measure in inches and metric units, and the basic math skills needed to use the micrometer.

✓ *Multimedia Reading a Rule: English and Metric Measurements*

Includes the basics of inches, feet, yards, halves, quarters, eighths, and sixteenths; the steps in calculating simple and compound fractions using the ruler; and a drill and practice in reading a ruler including simple and compound fractions. The metric instruction covers the same topics but using the metric system. Available on CD-ROM for IBM and Macintosh. Includes videos, audio, still photos, illustrations, animation, text materials, interactive lessons, and reproducible quizzes.

✓ *Occu-Math Lab*

In these lab activities, 14 different measuring tools used in major occupational clusters—including auto mechanics, construction, drafting, electronics, metals, and technology—are used to show students, in a hands-on format, how math applies to the world of work. Each individual lab activity includes a laminated how-to sheet, color transparency, real job-based measuring instrument, and applied problem-solving activities. Also included are **reproducible activity sheets** providing basic instruction and remediation in basic skill competencies.

✓ *Prevocational Math Software*

These four software packages teach addition, subtraction, multiplication, and division with whole numbers, decimals, fractions, and improper fractions. Available for IBM, Macintosh (B&W or color), and Apple.

✓ *Reading a Ruler*

The software packages (IBM, Macintosh, and Apple) in this series teach students the basics of English and metric measurements. An 18-minute videotape on reading English and metric rulers is also available.

✓ *School-to-Work: Vocational Math Connections*

Each IBM software package in this series provides students with applied math practice in a specific occupational area, including automotive, drafting/manufacturing, construction, and electronics. To increase student interest, various formats are used: games, real-life work site problems, two-dimensional color graphics, mouse interface, menu-driven, etc.

✓ *Think Tank: Applied Math*

With *Think Tank*, students use their applied math skills to solve problems they might actually encounter in a real job situation. Each print unit consists of a series of individual **job simulation activities**, teacher's guide, and answer sheets. The key critical thinking skills used to solve the problems found in each activity are also identified.

✓ *Vocational Math Pack*

The activities in this pack provide basic math instruction and practice, vocational word problems, applied vocational problems, and math/measuring tools vocabulary activity sheets. Packs, which include **reproducible worksheets**, pre/post-tests, a laminated guide, and transparencies, are available for 17 occupational areas, including electro-mech, industrial tech, auto mechanics, construction, electronics, and metals/welding.

✓ *Vocational Math Software*

The five software packages in this series provide a (1) prevocational math review and the mathematics skills needed for (2) estimating materials, (3) carpentry, (4) welding, and (5) automotive technicians. Available for IBM, Macintosh (B&W or color), and Apple.

✓ *Why Study Math*

Through on-the-job work scenes, this video shows that even the simplest job behavior requires math-related skills. It also demonstrates that keeping and advancing in a job require mastery of numerous math skills. **Reproducible worksheets** accompany the videocassette.

Center for Occupational Research and Development (CORD)

✓ *Applied Math: Course Materials*

Samples TP 000 140-143

These course materials stress applications in real-world job situations and allow for a broad range of student entry-level capabilities. The six activity sessions for each unit serve as a guide to the sequence of activities. An implementation notebook is also available. The teacher's guide for each unit contains a page-by-page annotation of the text for students, a teaching outline, correlation of unit goals and subunit objectives, supplementary resource lists, information about video segments, detailed lab prep instructions, and related information sources.

Contemporary Books

TP 000 611
- ✓ *Math Problem Solver: Reasoning Skills for Application*
  Text emphasizes translating word problems into mathematical language.

TP 000 625-626
- ✓ *Math Skills That Work: A Functional Approach for Life and Work*
  Book One covers working with whole numbers and money; sorting and filing numerically; writing checks; filling out receipts, purchase orders, and forms; balancing checkbooks; and interpreting paycheck stubs. Book Two covers using decimals, fractions, and percents; reading thermometers, rules, scales, and gauges; interpreting graphs and data; calculating commissions and interest; determining unit prices and extended costs; and understanding budgets and schedules.

TP 000 613
- ✓ *Number Power Review*
  Text covers from whole numbers to algebra, and prepares students to take—and pass—standard math assessment and competency exams.

Curriculum and Instructional Materials Center—Oklahoma

CIMC's Mathematics series emphasizes applied practice. Each instructional package is specifically oriented toward students pursuing vocational training and is supported by assignment sheets. Titles include the following:

- ✓ *Whole Numbers*
- ✓ *Fractions*
- ✓ *Measurement*
- ✓ *Decimals and Percents*
- ✓ *Geometry*

Delmar Publishers

- ✓ *Basic Technical Mathematics, 6th ed.*
  Math principles, illustrative examples, and problems throughout this text have been carefully selected to be representative of work situations confronted by entry-level workers in major vocational-technical occupations.

✓ *Math for the Automotive Trade, 3rd ed.*

Following a review of basic math skills, this text-workbook applies those skills to specific automotive situations. The final section examines measurement aspects, beginning with angle and linear measurements, and ending with an extensive look at measurement tools used in automotive trades.

✓ *Mathematics for Electricity and Electronics*

The necessary math for basic electricity and electronics is presented in this text, and special attention is paid to developing the problem-solving critical skills needed in these occupational areas. In every section, real electronics problems reinforce the link between mathematics and electronics.

✓ *Mathematics for Machine Technology, 3rd ed.* TP 000 025

Text covers common fractions and decimal fractions; linear measurement (English and metric); fundamentals of algebra, plane geometry, and trigonometry; compound angles; and numerical control.

✓ *Mathematics for Plumbers and Pipefitters, 5th ed.*

The basic math fundamentals for plumbers and pipefitters are reviewed in this text, including formulas/equations, length calculations, sheet metal work, volumes, pressures, capacities, heating, and use of the builder's level. Many standard, job-specific examples, illustrations, tables, and formulas are provided.

✓ *Practical Problems in Mathematics for Automotive Technicians, 4th ed.* TP 000 026

Math problems that cover situations technicians encounter in routine service work, as well as specialized technician problems, are covered in this text-workbook. Problems that deal with the operation of an automotive business are also addressed for students foreseeing business ownership.

✓ *Practical Problems in Mathematics for Carpenters, 6th ed.* TP 000 027

Designed for use with a carpentry text, this workbook focuses on problem-solving through sub-part word problems as a means to critical thinking. Specific math applications relating to the world of carpentry, as well as estimating of common projects, are presented.

✓ *Practical Problems in Mathematics for Drafting and CAD, 2nd ed.*

Through comprehensive compilation of integrated problems, this text fosters problem solving, critical thinking, and basic mathematics literacy. Realistic applications, and strategies for using a calculator to approach problems, are offered throughout the book.

✓ *Practical Problems in Mathematics for Electricians, 4th ed.*

Text covers whole numbers; common fractions; decimal fractions; percents, averages, and estimates; powers and roots; measure, ratio, and proportion; formulas; and trigonometry.

✓ *Practical Problems in Mathematics for Electricians, 5th ed.*

Basic math procedures used by electricians, as well as examples and solutions, are provided to help students develop and test new skills. Activities requiring problem solving and critical thinking are included throughout the text. The appendix includes detailed instructions on measurement, formulas, and trigonometric functions related directly to the electrical trade.

TP 000 028 ✓ *Practical Problems in Mathematics for Electronic Technicians, 3rd ed.*

Beginning with basic arithmetic and progressing through algebra and trigonometry, this text provides brief reviews of basic math principles at the start of each unit and concise explanations of the on-the-job skills needed for this trade area. Understanding of electronic symbols, basic circuits, component terminology; solution of multi-step problems through logical deductive thinking; and use of a calculator are reinforced throughout the text.

TP 000 029 ✓ *Practical Problems in Mathematics for Heating and Cooling Technicians, 2nd ed.*

Math problems in this text relate directly to the field of heating and air conditioning. Topics range from basic math operations involving whole numbers, decimals, and fractions, to finding areas and volumes, determining percentages and discounts, using basic formulas, and determining stretchouts.

✓ *Practical Problems in Mathematics for Industrial Technology*

Organized by math topics, this text covers a variety of industrial technology topics, including manufacturing, electricity/electronics, graphics, communication, transportation, industrial management, materials, and related science principles. Reinforced by examples and applications, the main objective is to develop strong, logical problem-solving skills.

✓ *Practical Problems in Mathematics for Machinists* TP 000 030

The contents of this text include whole numbers, common fractions, decimal fractions, direct measure, computed measure, percent and finance, graphs, shop formulas, ratio and proportion, powers and roots, geometric forms and construction, and trigonometry. Also included are two achievement reviews, a diagnostic survey of reading skills, and a glossary.

✓ *Practical Problems in Mathematics for Manufacturing, 4th ed.*

This text-workbook covers the basic math skills and applications encountered in the workplace by manufacturing technicians. Practical exercises are presented in clear, easy-to-follow steps, offering a systematic approach to mastering essential mathematical skills. Critical thinking exercises assist students in using research to locate answers. Chapters on fractions, geometric forms, and trigonometry provide a broad range of practical knowledge used in the machinery field.

✓ *Practical Problems in Mathematics for Masons* TP 000 031

Text provides students with practical and realistic problems encountered by masons. Solution of these problems strengthens students' technical and mathematical skills.

✓ *Practical Problems in Mathematics for Mechanical Drafting* TP 000 032

Text covers whole numbers, common fractions, decimal fractions, measurement, percentages, averages, finance and graphs, applied algebra, applied geometry, and applied trigonometry. Achievement reviews are included.

TP 000 033

✓ *Practical Problems in Mathematics for Welders, 4th ed.*

This workbook provides a concise review of the mathematics principles used in the welding shop. Each unit begins with a review of the basic procedures used in standard operations and then builds to feature more advanced formulas and procedures. Includes real on-the-job examples and problems, as well as updates on present-day shop practices in the welding field.

✓ *Technical Mathematics*

Using a highly visual approach, this text provides **over 5,000 problems and exercises** covering a wide variety of professional fields to reinforce important mathematical concepts and provide opportunities for students to develop on-the-job problem-solving skills.

✓ *Technical Mathematics with Calculus*

This text contains the same material as Technical Mathematics, with additional chapters that cover calculus—from an introduction through differential equations and numerical methods. Provides **over 8,500 problems and exercises** covering a wide variety of professional fields.

VT 000 034

✓ *Vocational-Technical Mathematics, 3rd ed.*

Practical examples from various occupations are shown in this text to illustrate the actual on-the-job uses of basic math, algebra, geometry, and trigonometry. Step-by-step instructions are provided for solving problems on the job. Emphasis is placed on the ability of the student to think and work with equal ease with both English and metric systems.

Glencoe/McGraw-Hill

✓ *A Mathematical Journey*

This text introduces students to the unexpected ways in which math can be useful in everyday life. Through art, history, psychology, biology, politics, economics, finance, and sports connections, the text encourages students to get involved with the math skills they learn. With three levels of activities in each chapter, a variety of exercises, and interesting analogies, this program is designed to encourage students to think mathematically as they learn to question, discover, and experiment with the world of math.

✓ *Merrill Algebra 1: Applications and Connections*

✓ *Merrill Algebra 2 with Trigonometry: Applications and Connections*

✓ *Merrill Geometry: Applications and Connections*

These texts provide relevant applications and connections to encourage students to investigate the content; problem-solving opportunities to give students a deeper understanding of math concepts and sharpen their critical-thinking skills; extended projects to give students the opportunity to work in cooperative groups or individually on long-range projects; activities using manipulatives and the graphing calculator; and tech prep applications that use real-life problem solving to show students how the math skills being learned are used in the workplace.

✓ *Merrill Mathematics Connections: Essentials and Applications*

Written for students not planning to attend college, this text presents topics in a step-by-step manner, with algebra introduced in Chapter 1 and its use integrated throughout the remainder of the text. Connections to other mathematical topics and real-world applications are included to help enhance student understanding.

Goodheart-Wilcox

✓ *Applied Mathematics*

Designed to teach sound math skills through realistic applications, the text integrates math concepts with real-world technical applications. Practice problems are reinforced with step-by-step sample problems. Concepts covered include solving word problems; fractions; percentage; personal finance; graphs; units of measure, perimeter, area, and volume; reading tools of measurement; signed numbers and operations; algebraic equations and inequalities; solving problems with algebra; applied trigonometry; scientific and engineering notation; basic relationships of electricity; and introduction to estimating.

✓ *Basic Mathematics*

Step-by-step instructions in this combination text-workbook are reinforced with sample problems illustrating the application of each basic math skill in various occupations. Exercises and drills are provided to help students develop accuracy and speed in the math skills covered.

✓ *Math for Welders*

This combination text-workbook teaches basic math skills (whole numbers, common fractions, decimal fractions, measurement, and percentages) and provides application of those skills through 180 practical exercises useful in the welding field.

Houghton Mifflin Company

TP 000 379 ✓ *Integrated Mathematics*

The goal of this text is to develop students' abilities to explore and solve mathematical problems, think critically, work cooperatively with others, and communicate ideas clearly. The units included in this (the first of three texts) are exploring and communicating mathematics; using measures and equations; representing data; coordinates and functions; equations for problem solving; ratios, probability, and similarity; direct variation; linear equations as models; reasoning and measurement; and quadratic equations as models.

TP 000 380 ✓ *Integrated Mathematics. Teacher's Edition*

The teacher's edition discusses the integrated math program, presents teaching strategies, and provides information on how to use the teacher's edition. The student text with answers and teaching notes is included.

TP 000 426 ✓ *Mathematical Connections: A Bridge to Algebra and Geometry*

Topics covered in this text include arithmetic to algebra; integers; equations; graphs and data analysis; geometry; number theory and fraction concepts; rational numbers; ratio, proportion, and percent; circles and polygons; statistics and circle graphs; probability; inequalities and graphing on the coordinate plane; surface area and volume; and polynomials.

Lakeshore Learning Materials

Lakeshore Basics & Beyond materials are designed for students who are hard to reach, at risk of dropping out, or in need of a fresh approach to learning. If you have students in need of remediation or if you are looking for simple, reproducible hands-on activities and cooperative projects for mathematics, Lakeshore may be a good source for you. Some examples of **videos**, **worktexts**, **texts**, and **activity books** that could be of interest follow.

✓ *Algebra and Geometry Videos*
✓ *Hands-on Math! Activities*
✓ *Hands-on Measurement Program*
✓ *Math for Careers Worktext*
✓ *Math for the Real World Worktext Program*
✓ *Math Measurement for the World of Work*
✓ *Math Stories for Problem Solving Success*
✓ *Real-World Math Through Science Activity Series*
✓ *Real World Math Worktext Series: Math for Employment*
✓ *Vocational Math Series*
✓ *Working Makes Sense Activity Book*

Mathematical Association of America (MAA)

✓ *Learning by Discovery: A Lab Manual for Calculus* TP 000 122
These 28 laboratory modules can be used as lab components or assigned as independent projects.

✓ *The Laboratory Approach to Teaching Calculus* TP 000 123
In this text, 26 academic institutions that have used the laboratory approach to teaching calculus evaluate their experiences and tell what has worked for them and what has not. A range of experiences is presented.

National Tooling and Machining Association

✓ *Mathematics for Machinists*

Using a self-paced approach, students progress through activities emphasizing the application of math to the working environment. References are made to shop prints, practical work, and problem solving.

✓ *Practical Mathematics for Metalworking Trainees*

Focused specifically on the machining industry, this text presents the elements of math that must be mastered before a student can become proficient in machine shop set-up procedures. The materials provide students with an intensive, but practical, working knowledge of arithmetic (fractions, mixed numbers, decimals, and related conversions); algebra (algebraic rules, equations, and symbols); geometry (axioms, definitions, propositions, and symbols); trigonometry (the unit circle, functions and laws, tables, and interpolation); and metrics (introduction, conversion, and dimensions).

Prentice Hall

TP 000 428

✓ *Technical Mathematics, 2nd ed.*

Topics covered in this text include numerical computation; introduction to algebra; simple equations and word problems; functions and graphs; geometry; right triangles and vectors; factors and factoring; fractions and fractional equations; systems of linear equations; determinants; matrices; exponents and radicals; quadratic equations; oblique triangles; radian measure, arch length, and rotation; graphs of the trigonometric functions; trigonometric identities and equations; ratio, proportion, and variation; exponential and logarithmic functions; complex numbers; and precalculus material. Discussion of many technical applications is included to show that mathematics has real-world uses.

South-Western Educational Publishing

✓ *Algeblocks*

These **reproducible lab activities** and hands-on, student-friendly **manipulatives** help students experience and visualize algebraic concepts at a concrete level. Also available in an interactive **software version**.

✓ *Algebra 1: An Integrated Approach*

This text uses a thematic approach to teaching algebra, with real-life applications, interdisciplinary connections, and connections within mathematics. The chapters cover data and graphs; variables, expressions, and real numbers; linear equations; functions and graphs; linear inequalities; linear functions and graphs; systems of linear equations; systems of linear inequalities; absolute value and the real number system; quadratic functions and equations; polynomials and exponents; polynomials and factoring; geometry and radical expressions; and rational expressions.

Each chapter is organized around a theme. The theme for the chapter on functions and graphs, for example, is sports. The math concepts are all presented in relation to sports-related problems. Teamwork is encouraged; students are asked to solve problems working in small groups and pairs. After a concept is explained, activities give students the opportunity to apply the concept (practice), extend their understanding, and think critically.

Each chapter ends with a project. For the sports theme, the project is to collect, organize, and analyze school sports data and create a Sports Showcase. An Internet address is provided to help students research each project online. Related careers (and the math involved in them) are highlighted throughout each chapter. The sports careers described are greenskeeper, sports referee, and sports statistician.

The **total package** includes not only the text, but also transparencies, theme posters, topic posters, themes video and videodisc, algeblocks, annotated teacher's edition, software-generated assessment, and a teaching resources box with resource books, math handbooks, technology activities for graphing calculator and computer software, study skills activities, and lesson plans.

✓ *Algebra 2: An Integrated Approach*
Similar in format to *Algebra 1* described above, this text covers modeling and predicting; real numbers, equations, and inequalities; functions and graphs; systems of linear equations; polynomials and factoring; quadratic functions and equations; inequalities and linear programming; exponents and radicals; exponential and logarithmic functions; polynomial functions; rational expressions and equations; conic sections; sequences and series; probability; trigonometric functions; and trigonometric equations and identities.

✓ *Math Matters: An Integrated Approach*
Similar in format to *Algebra 1* and *Algebra 2*, this three-book program reinforces the connections between algebra and geometry, while developing problem-solving skills. Working with themes that apply to their everyday lives, students explore new math concepts and generalizations by weaving together number sense, algebra, geometry, statistics, and logic.

✓ *Vocational Mathematics, 4E*
Firmly rooted in the basics, this text covers decimals, fractions, equivalents, and measurements and applies the concepts to vocational problems.

Sunburst Communications

✓ *Data Visualization: Meaningful Math*
Using dozens of examples based on real-world situations, this text helps students learn how to describe data with graphs and statistics, discover the best way to describe a set of data, read what the data is saying, and communicate the information through a picture.

✓ *Math Vantage Videos—Patterns Unit*

TP 000 656-661

Math becomes a living subject through these five motivational videos developed by the Nebraska Mathematics and Science Initiative. Designed to enable students to use patterns to explain, create, and predict situations, each topic covered emphasizes problem-solving techniques. Separate videos cover discovering patterns; patterns with ten; sequences and ratios; tessallations; and networks, paths, and knots. Although developed for students in Grades 6-9, these videos could easily be used as supplementary resources for students needing remediation. A teacher's resource book supports the videos.

✓ *Visualizing Algebra: Algebra Problems and Projects for the Function Analyzer*

TP 000 642

Designed to be used with *Visualizing Algebra: The Function Analyzer*, this text provides activities for exploring such topics as points and functions in the coordinate plane; investigating functions in symbolic, graphical, and numerical forms; studying polynomial functions and composition of functions; factoring polynomials; and solving equations.

USA TODAY

✓ *How to Teach Math with USA TODAY*

Designed in partnership with the National Council of Teachers of Mathematics, this teaching guide has students solve real-world math problems using mathematical reasoning. The supplementary student *Stat Book* uses baseball as its theme and challenges kids to use computer statistics to draft their own fantasy league teams. Although the materials are designed for middle school level, they contain ideas that could be adapted and used in applied classes at the senior high school level.

✓ *Algebra by Example*

After a pretest that pinpoints students' areas of weakness, this software presents hands-on problem-solving experience. Help functions are included to assist students through problems one step at a time. Covers arithmetic operations; real numbers; equations in one variable; using formulas; graphing equations; linear equations in two variables; addition, subtraction, multiplication, and factoring of polynomials; exponents; logarithms and quadratic equations; and word problems. Available for IBM only.

✓ *Construction Geometry*

This text contains special construction concepts and graphic solutions to practical problems encountered by builders.

✓ *Introduction to Linear Measurement*

This **package** presents the English and metric systems, covering how measurement skills are used, as well as the conversion and computation of fractions. It includes a video, teacher's handbook, and 10 student handbooks.

✓ *Live-Action Video Series*

These videos present mathematical topics using animation and an electronic chalkboard. They can be used for classroom presentations and to help individual students needing extra help, review, or remediation. Videos are available for the following topics: percents, decimals, fractions, pre-algebra, basic word problems, basic number concepts, and basic geometry.

✓ *Math to Build On*

An easy-to-follow format is used in this text to present the basic math skills used in the **construction trades** (fractions, decimals, basic geometry, and trigonometry). Memory aids, practical applications, and calculator use are included.

✓ *Pipe Fitter's Math Guide*

Illustrations, practical examples and problems, tables/charts, and a glossary are provided in this text to help students master the basic math related to the pipe fitting trade.

✓ *Precision Measuring*

This set of videos is designed to take students step by step through the reading, use, and care of precision measuring tools. Individual videos are available for the outside micrometer, combination set, combination square, bevel protractor, vernier caliper, and vernier height gage.

Applied Science

American Chemical Society Career Education

TP 000 093-104

✓ *Science and Technology in Society (SATIS) Curriculum Materials*
This 12-volume set contains **120 different activities** to help teachers relate important issues in technology or society to current science lessons. Black-and-white pages are copyright-waived so teachers can make as many copies as needed. A comprehensive index is provided to help teachers select appropriate activities. A teacher's guide gives further ideas, resources, and assistance in teaching using nontraditional approaches.

Cambridge Educational

✓ *Multimedia Applied Biology/Chemistry*
Covers the following three units: natural resources, air and other gases, and nutrition. Available on CD-ROM for IBM and Macintosh. Includes videos, audio, still photos, illustrations, animation, text materials, interactive lessons, and reproducible quizzes.

✓ *Principles of Technology*
The 14 software units in this series are designed for use in programs using Principles of Technology, the applied physics course designed by the Center for Occupational Research and Development (CORD) and the Agency for Instructional Technology (AIT). The units provide an alternative teaching tool (e.g., for students who need to make up work or who need to spend more time mastering a concept), as well as an evaluation tool. Units cover the following concepts and principles: force, work, rate, resistance, energy, power, simple machines, momentum, waves and vibrations, energy converters, transducers, radiation, light and optical systems, and time constants. Available for IBM and Macintosh.

✓ *Principles of Technology Multimedia Series*
Designed to be used with the CORD/AIT applied physics materials, these CD-ROMs provide training and testing capacity related to the 14 units listed in the previous description. Available for IBM and Macintosh.

✓ *Think Tank: Applied Science*
With ***Think Tank***, students use their applied science skills to solve problems they might actually encounter in a real job situation. Each print unit consists of a series of **individual job simulation activities**, teacher's guide, and answer sheets. The key critical thinking skills used to solve the problems found in each activity are also identified.

Center for Occupational Research and Development (CORD)

TP 000 829-852, 882 ✓ *Applications in Biology/Chemistry: A Contextual Approach to Laboratory Science*
The ABC materials consist of 12 units: natural resources, water, air and other gases, continuity of life, nutrition, disease and wellness, plant growth and reproduction, life processes, microorganisms, synthetic materials, waste and waste management, and community of life.

TP 000 105 ✓ *Applied Biology/Chemistry Teacher's Guide*
The teacher's guide for each of the 12 units contains a page-by-page annotation of the text for students, a teaching outline, correlation of unit goals and subunit objectives, supplementary resource lists, information about video segments, detailed lab prep instructions, and related information sources.

TP 000 113 ✓ *Physics for Technicians—A Systems Approach*
Designed for a two-semester or three-quarter course for postsecondary students, this Wiley text provides more than an introduction to basic physics. It could be used at the secondary level as a teacher resource or supplementary reference for more advanced students.

✓ *Principles of Technology. Course Materials*

The PT course is designed to prepare students more effectively for technical careers. The first class for each unit is an introduction and overview of the unit's contents. The last class is designed for a review/summary and test. The 24 intervening lessons are divided into four subunits of six classes each.

Samples TP 000 151-153

Goodheart-Wilcox

✓ *Energy: Sources/Applications/Alternatives*

This text is designed to support industrial/technology education programs.

Kendall/Hunt Publishing Company

✓ *ChemCom—Chemistry and Community: A Solution with Substance*

TP 000 106

Produced by the American Chemical Society, this text uses intriguing activities to make students aware of chemistry-related issues in their community and their potential contributions to those issues. Students learn and use chemical facts and concepts as needed to understand the societal issues being addressed, and their interest in chemistry grows as they discover its real-world applications.

Lakeshore Learning Materials

Lakeshore Basics & Beyond materials are designed for students who are hard to reach, at risk of dropping out, or in need of a fresh approach to learning. If you have students in need of remediation or if you are looking for simple, reproducible hands-on activities and cooperative projects for science, Lakeshore may be a good source for you. Some examples of **labs**, **manipulatives**, **activity books**, and **references** that could be of interest follow.

- ✓ *100 Ready-to-Use Chemistry Activities*
- ✓ *100 Ready-to-Use Physical Science Activities*
- ✓ *300 Ready-to-Use Science Activities*
- ✓ *Cooperative Learning Science Experiences*
- ✓ *Everyday Science: Real-Life Activities*
- ✓ *Hands-on Science! 112 High-Interest Activities*
- ✓ *Simple Machines Hands-on Lab*
- ✓ *Simple Machines Manipulative Kit*
- ✓ *Motorized Machines Hands-on Lab*
- ✓ *Motorized Machines Manipulative Kit*
- ✓ *Science at Your Fingertips Photo Encyclopedia*
  Includes seven books covering force and motion, electricity, light, energy, human body, life, and chemistry.

Prentice Hall

- ✓ The Globe Fearon division of Prentice Hall publishes biology texts geared to the interest level of Grades 6-12, but with reading levels at Grades 2-4.

- ✓ *Chemistry and Our Changing World*
  Using an applications-oriented approach, this text focuses on problem solving and the relationship of chemistry to the everyday world.

Sunburst Communications

TP 000 646-655

✓ *The World of Chemistry Videos*
These video and print materials—designed by high school teachers with the help of their students—provide demonstrations, experiments, and suggestions for research projects within an integrated curriculum. Each videotape is 30 minutes long, contains two programs, and is accompanied by a teacher's guide. Videos cover color/measurement; states of matter/the mole; the atom/the periodic table; chemical bonds/organic chemistry; molecular fingerprints/water; the atmosphere/the driving forces; chemical kinetics/catalysts; acids and bases/chemistry of the earth; oxidation and reduction/metals; and polymers/biochemistry.

USA TODAY

✓ *Earth Today*
This environmental education program teaches students to examine the environmental issues that affect their daily lives. Students learn about cycles, ecosystems, and resources and discover what other students, businesses, and people across the nation are doing to protect our planet.

Vocational Marketing Services

✓ *The Art of Construction: Principles and Projects for Beginning Engineers and Architects*
Useful for Principles of Technology classes, this text presents basic construction principles and classroom projects that demonstrate these principles.

✓ *Fantastic Paper Flying Machines*
Twenty designs are provided for making exciting, aerodynamic fliers with ordinary paper. Each design takes less than 10 minutes to make.

✓ *Introduction to Simple Machines*

This **package** on the simple machine includes a video, teacher's handbook, and 10 student handbooks. Covers the theory and application of levers, pulley systems, the wheel and axle, the inclined plane, the screw, and related concepts.

✓ *Paper Planes*

This software provides a paper airplane tutorial to guide students in the building and flying of dozens of simple and complex planes in just minutes.

✓ *Why Buildings Fall Down*

A feast of architectural flops and flummoxes are presented in this text as the reader journeys through the history of architectural and structural disasters.

✓ *Why Buildings Stand Up: The Strength of Architecture*

This text looks at buildings from the nomad's tent to the Sears Tower and describes the revolution that has occurred over time in the technology and materials of buildings, in structures, and in the way buildings look.

✓ *The Way Things Work*

Also useful for Principles of Technology classes, this text tells and shows how things work and why. In the illustrations, gears, cams, and levers are worked by miniature people, while a woolly mammoth does the experiments.

Contact Information

Agency for Instructional Technology (AIT)
Phone: 800-457-4509

American Chemical Society Career Education
Phone: 800-227-5558
Fax: 202-872-4615
Website: <http://www.acs.org>

American Tech
Phone: 800-323-3471
Fax: 708-957-1137

Association for Supervision and Curriculum Development (ASCD)
Phone: 703-549-9110
Fax: 703-549-3891
Website: <http://www.ascd.org>

Bergwall Productions, Inc.
Phone: 800-645-3565

Cambridge Educational
Phone: 800-468-4227
Fax: 304-744-9351
Website: <http://www.cambridgeol.com>

Career Communications, Inc.
Phone: 800-669-7795
Fax: 913-362-4864
E-mail: <ccinfo@carcom.com>
Website: <http://www.carcom.com>

Center for Occupational Research and Development (CORD)
Phone: 800-231-3015
Fax: 817-772-8972
E-mail: <stw@cord.org>
Website: <http://www.cord.org>

Contemporary Books
Phone: 800-621-1918
Fax: 312-540-4687
Website: <http://www.tribune.com/financials/1994_annual/businesses/contemporarybooks.html>

Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and Technical Education
Phone: 800-654-4502
Fax: 405-743-5154
Website: <http://www.okvotech.org/cimc/home.htm>

Curriculum Materials Service
Ohio Agricultural Education
Phone: 614-292-4848
Fax: 800-292-4919
E-mail <wwaideli@magnus.acs.ohio-state.edu>
Website: <http://ad254-5.ag.ohiostate.edu/OCMS/OCMS.html>

Curriculum Publications Clearinghouse
Illinois State Board of Education
Phone: 800-322-3905
Fax: 309-298-2869
E-mail: <CPC@wiu.edu>
Website: <http://www.wiu.edu/users/micpc/wiu/index.html>

Delmar Publishers
Phone: 800-354-9706
Fax: 800-487-8488
E-mail: <search@catalog.thomson.com>
Website: <http://www.thomson.com/delmar>

EDINFO Press
ERIC Clearinghouse for Reading and Communication Skills
Phone: 800-925-7853
Website: <http://www.indiana.edu/~eric_rec>

Glencoe/McGraw-Hill
Phone: 800-334-7344
Fax: 614-860-1877
Website: <http://www.glencoe.com>

Goodheart-Wilcox
Phone: 800-323-0440
Fax: 708-687-5068

Great Source
Houghton Mifflin
Phone: 800-289-4490
Website: <http://www.hmco.com/hmco/greatsource/index.html>

Houghton Mifflin Company
Phone: 800-733-2828
Fax: 800-733-2098
Website: <http://www.hmco.com>

Kendall/Hunt Publishing Company
Phone: 800-228-0810

Lakeshore Learning Materials
Phone: 800-421-5354
Fax: 310-537-5403

Mathematical Association of America (MAA)
Phone: 800-331-1622
Website: <http://www.maa.org>

National Tooling and Machining Association
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Fax: 301-248-2755
Website: <http://www.ntma.org>

Paradigm Marketing Group, Inc.
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Prentice Hall
Phone: 800-288-4745
Website: <http://www.prenhall.com>

Procter & Gamble Educational Services
P. O. Box 599, Cincinnati, OH 45201-0599
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South-Western Educational Publishing
Phone: 800-354-9706
Fax: 800-487-8488
E-mail: <search@catalog.thomson.com>
Website: <http://www.thomson.com/swpco.html
Math Discussion List:
Send message to <majordomo@list.thomson.com>
Type only <subscribe south-western-math; *your_email_address*>

Sunburst Communications
Phone: 800-321-7511
E-mail: <service@nysunburst.com>
Website: <http://www.nysunburst.com>

USA TODAY
Phone: 800-757-TEACH
Website: <http://web.usatoday.com>

Virginia Vocational Curriculum and Resource Center
Phone: 804-261-5075
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Website: <http://vvcrc.tec.va.us>

Vocational Marketing Services
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OCAP

OCCUPATIONAL COMPETENCY ANALYSIS PROFILE

PRECISION MACHINING TECHNOLOGIES

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Vocational Education

Division of Vocational and Adult Education
Ohio Department of Education

VML

Vocational Instructional Materials Laboratory
Center on Education and Training for Employment

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Verification Panels .... Inside back cover

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Introduction

What is an OCAP?

According to the *Action Plan for Accelerating the Modernization of Vocational Education: Ohio's Future at Work*—

> A comprehensive and verified employer competency list will be developed and kept current for each program
>
> —Imperative 3, Objective 2—

The Occupational Competency Analysis Profiles (OCAPs) are the Ohio Division of Vocational and Adult Education's response to that objective.

OCAPs are competency lists—verified by expert workers—that evolve from a modified DACUM job analysis process involving business, industry, labor, and community agency representatives from throughout Ohio. The OCAP process is directed by the Vocational Instructional Materials Laboratory located at The Ohio State University's Center on Education and Training for Employment.

How is the OCAP used?

Each OCAP identifies the occupational, academic, and employability skills (or competencies) needed to enter a given occupation or occupational area. The OCAP not only lists the *competencies* but also clusters those competencies into broader *units* and details the knowledge, skills, and attitudes (*competency builders*) needed to perform each competency.

Within the competency list are two levels of items: core and advancing. *Core items*, which are essential for entry-level employment, are required to be taught and are the basis for questions on the Ohio Vocational Competency Assessment (OVCA). *Advancing items* (marked with an asterisk) are those needed to advance in a given occupation.

School districts may add as many units, competencies, and/or competency builders as desired to reflect local employment needs, trends, and specialties. Local advisory committees should be actively involved in the identification and verification of additional items. Vocational and applied academic instructors will be able to formulate their courses of study using the varied contents of the OCAP and will be able to monitor competency gains via the new criterion-referenced competency testing program, which is tied to the competencies identified on the OCAP.

Unit 2: Measuring Workpieces

Competency 2.1: Interpret different measuring systems

Competency Builders:

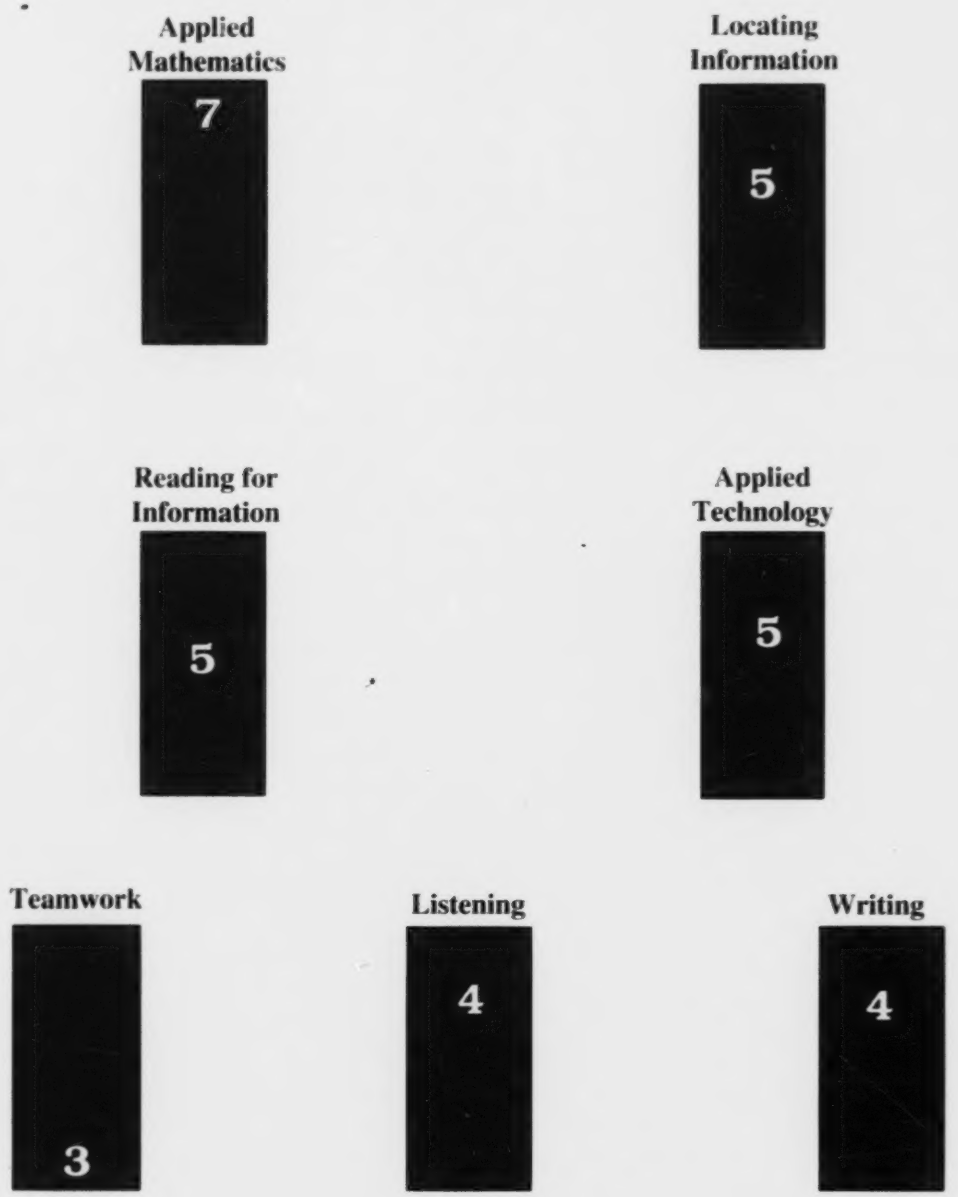
2.1.1 Demonstrate knowledge of the English system of measurement
2.1.2 Demonstrate knowledge of the metric system of measurement
2.1.3 Demonstrate knowledge of measurement standards and fit designations
2.1.4 Convert measurements from the metric to English system and vice versa

Competency 2.2: Use measuring tools

Competency Builders:

2.2.1 Demonstrate knowledge of the applications/functions of each basic measuring tool
2.2.2 Select the appropriate measuring tool for a given job
2.2.3 Make linear measurements using a steel rule
2.2.4 Measure inside diameter (ID) and outside diameter (OD) using inside, outside, or hermaphrodite calipers
2.2.5 Measure linear dimensions using dividers
2.2.6 Make a variety of measurements using a combination square
2.2.7 Check the accuracy of thread size and pitch using a thread pitch gage
2.2.8 Locate the center of a workpiece using a center gage
2.2.9 Check the accuracy of drill point angle using a drill point gage
2.2.10 Measure angles using a protractor
2.2.11 Measure depth for a groove hole, recess, or step using a depth gage
2.2.12 Check the accuracy of internal dimensions using a feeler gage
2.2.13 Check the accuracy of external and internal dimensions using plug and ring gages
2.2.14 Make very small internal measurements by transfer using a small-hole gage
2.2.15 Make very small internal measurements by transfer using a telescoping gage
2.2.16 Measure internal dimensions using an inside micrometer
2.2.17 Measure external dimensions using an outside micrometer
2.2.18 Measure internal and external dimensions and surface depth using vernier calipers
2.2.19 Measure internal and external dimensions and surface depth using a dial caliper
2.2.20 Measure the depth of a feature using a depth micrometer
2.2.21 Measure angular surfaces using a sine bar
2.2.22 Check sizes, measurements, and alignment against a known standard using a dial indicator
2.2.23 Check hole diameters and bores using a dial bore gage
2.2.24 Measure workpieces using a height gage
2.2.25 Verify instrument accuracy using Jo blocks
2.2.26 Maintain tools (e.g., clean, calibrate)
2.2.27 Demonstrate knowledge of the characteristics and functions of Go/No-Go gages
2.2.28 Demonstrate knowledge of the characteristics and functions of snap gages
2.2.29 Demonstrate knowledge of the characteristics and functions of taper plug gages
2.2.30 Demonstrate knowledge of the characteristics and functions of cylindrical squares
2.2.31 Demonstrate knowledge of the characteristics and functions of thread wires
2.2.32 Demonstrate knowledge of the characteristics and functions of universal bevel protractors
2.2.33 Demonstrate knowledge of the characteristics and functions of electronic measuring devices
2.2.34 Demonstrate knowledge of the characteristics and functions of optical comparators

Academic Job Profile: Precision Machining Technologies



NOTE: Definitions of each level in each of the seven academic skill areas are provided on the pages that follow.

Academic Competencies: Precision Machining Technologies

The Precision Machining Technologies OCAP panel of expert workers (see member list on the inside back cover) identified the following academic competencies (from the total list, pp. 48-62) as most crucial to the entry-level success of an employee in the area of precision machining technologies. It is recommended that these competencies be taught in an applied manner for students enrolled in precision machining technologies programs.

Unit: Communications Skills

Subunit: Reading—Structure

Competencies:

RS1	Exhibit knowledge of language structure
RS5	Develop and use an increasingly sophisticated vocabulary gained through context
RS15	Apply an expanding vocabulary gained through reading

Subunit: Reading—Meaning Construction

Competencies:

RM3	Read to clarify personal thinking and knowledge
RM12	Use reading as a possible problem-solving strategy to clarify personal thinking and knowledge

Subunit: Reading—Application

Competencies:

RA1	Select and read material for personal enjoyment and information
RA7	Extend value of reading, writing, speaking, viewing, and listening by pursuing, through reading, new concepts and interests developed as a result of these activities

Subunit: Reading—Multidisciplinary

Competencies:

RM9	Read to facilitate content learning

Subunit: Writing—Structure

Competencies:

WS3	Locate and correct errors in usage, spelling, and mechanics (e.g., subject-verb agreement, parallel construction, pronoun reference, punctuation, capitalization, sentence structure) using a variety of resources
WS4	Recognize information gained from primary and secondary sources
WS5	Develop writing that contains ordered, related, well-developed paragraphs with sentences of varied lengths and patterns

Subunit: Writing—Meaning Construction

Competencies:

WM3	Respond to others' suggested revisions to a piece of writing (e.g., self-question, re-read, revise)
WM10	Recognize and refine personal writing styles

Subunit: Writing—Application

Competencies:

WA1	Apply appropriate writing techniques (e.g., prewriting, drafting, revising, editing, presenting) suitable for varied writing tasks
WA9	Make judicious use of reference sources (e.g., dictionary, thesaurus, online database, encyclopedia)

Subunit: Writing—Multidisciplinary

Competencies:

WM4	Write in response to reading, speaking, viewing, and listening

Subunit: Listening/Visual Literacy—Structure

Competencies:

LS4	Expand vocabulary through listening to and viewing varied media (e.g., recordings, films, music, news broadcasts)

Subunit: Listening/Visual Literacy—Meaning Construction

Competencies:

LM1	Develop critical thinking skills necessary to evaluate media and assess oral presentations

Subunit: Listening/Visual Literacy—Application

Competencies:

LA1	Listen attentively during oral reading

Subunit: Oral Communication—Structure

Competencies:

OS1	Refine oral communication skills (e.g., voice modulation, eye contact, body language)
OS4	Organize notes and ideas for speaking (e.g., cause-effect, chronological, exemplification)
OS7	Organize notes and ideas for formal, semiformal, and informal presentations of information

Subunit: Oral Communications—Meaning Construction

Competencies:

OM1	Make connections between prior knowledge and new information for oral presentations
OM2	Participate in informal speaking activities (e.g., offering opinions, supporting statements, questions, clarification, entertainment)
OM5	Participate in group communication activities (e.g., debates, panel discussions, negotiations, book-sharing, roundtables, cooperative/collaborative groups)

Subunit: Oral Communications—Multidisciplinary

Competencies:

OM1	Value thinking and language of others

Unit: Mathematics Skills

Subunit: Numbers and Number Relations

Competencies:

NR1	Compare, order, and determine equivalence of real numbers
NR2	Estimate answers, compute, and solve problems involving real numbers

Subunit: Measurement

Competencies:

M1	Estimate and use measurements
M2	Understand the need for measurement and the probability that any measurement is accurate to some designated specification
M9	Construct and interpret maps, tables, charts, and graphs as they relate to real-world mathematics
M11	Understand and solve right triangle relationships as they relate to measurement—specifically those that deal with the Pythagorean theorem
M16	Develop an ability to identify real problems and provide possible solutions
M17	Express and apply different types of measurement scales
M18	Determine area and volume

Subunit: Estimation and Mental Computation

Competencies:

E4	Use mental computation when computer and calculator are inappropriate

Subunit: Data Analysis and Probability

Competencies:

D1	Organize data into tables, charts, and graphs

Subunit: Algebra

Competencies:

A1	Describe problem situations by using and relating numerical, symbolic, and graphical representations
A9	Determine slope, midpoint, and distance
A13	Set up and solve linear equations
A20	Explore geometric basis for functions of trigonometry
A29	Decide whether problem situation is best solved using computer, calculator, paper and pencil, or mental arithmetic/estimation techniques
A37	Simplify algebraic expressions

Subunit: Geometry

Competencies:

G1	Create and interpret drawings of three-dimensional objects
G3	Apply Pythagorean theorem
G4	Demonstrate knowledge of angles and parallel and perpendicular lines
G9	Use deductive reasoning

Subunit: Patterns, Relations, and Functions

Competencies:

P3	Translate among tables, algebraic expressions, and graphs of functions
P8	Apply trigonometric functions to problem situations involving triangles
P10	Explore periodic real-world phenomena using sine and cosine functions
P16	Solve trigonometric equations, and verify trigonometric identities

Unit: Science Skills

Subunit: Scientific Inquiry

Competencies:

Q1	Check the appropriateness and accuracy of measures and computations using various strategies (e.g., estimations, unit analysis, determination of significant figures)
Q3	Translate information from and represent information in various forms with equal ease (e.g., tables, charts, graphs, diagrams, geometric figures)
Q4	Use existing algebraic formulas and create new ones in appropriate problem-solving situations
Q6	Invent apparatus and mechanical tools needed to perform unique tasks in various situations
Q9	Make and read scale drawings, maps, models, and other representations to aid planning and understanding
Q11	Use appropriate units for counts and measures
Q14	Communicate the results of investigations clearly in a variety of situations
Q17	Select, invent, and use tools, including analog and digital instruments, to make and record direct measurements
Q34	Create, standardize, and document procedures
Q40	Draw conclusions based on the relationships among data analysis, experimental design, and possible models and theories

Subunit: Conditions for Learning Science

Competencies:

C25	Listen attentively and critically to presentations of scientific information made by others

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